Product Engineering

THE McGRAW-HILL MAGAZINE OF DESIGN ENGINEERING
FIVE DOLLARS A YEAR

SEPTEMBER 1954

HOW TO SELECT

Mechanical Components

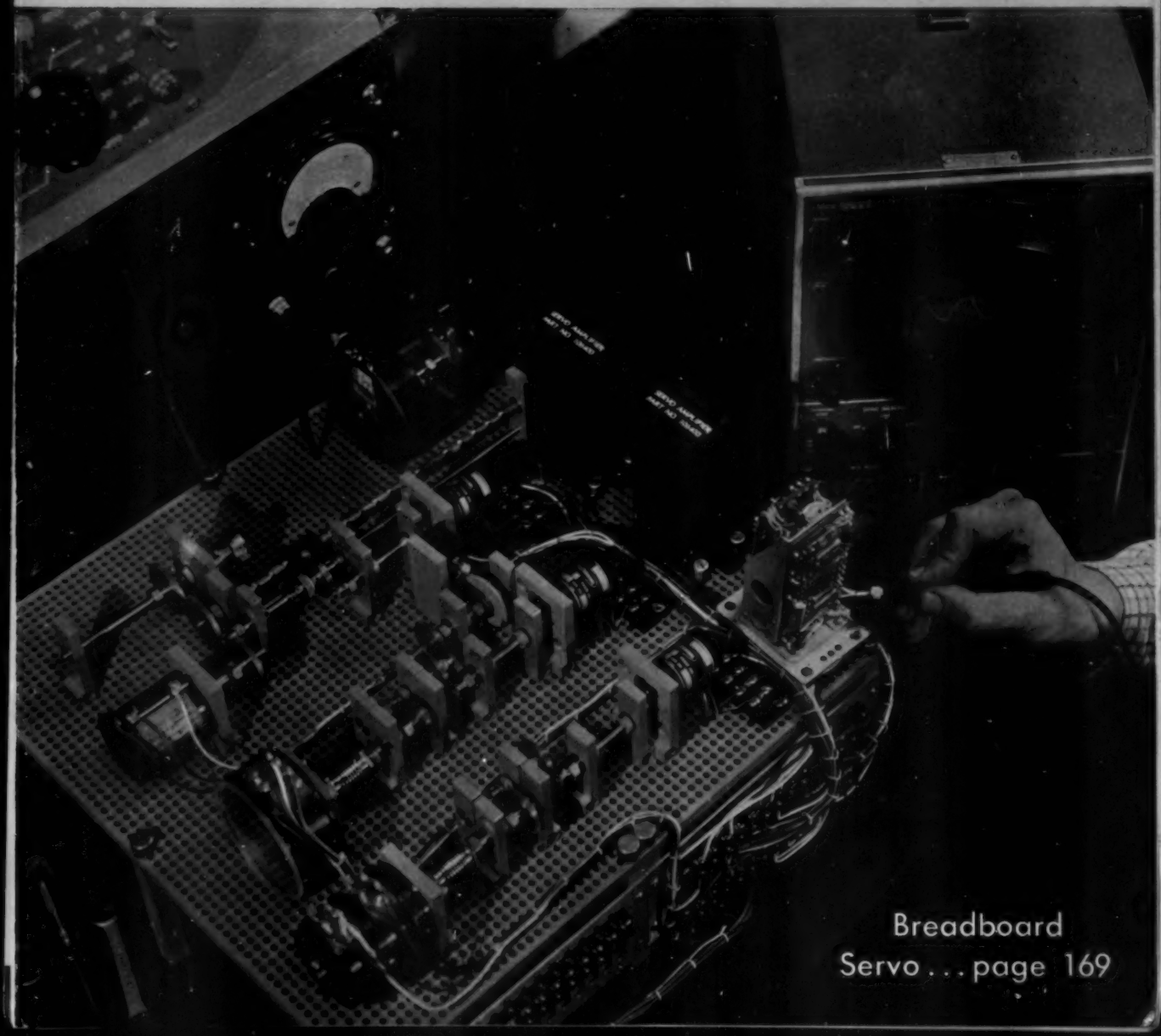
FOR AUTOMATIC CONTROL

•

Constant-Force Springs

Resilient Epoxy Plastics

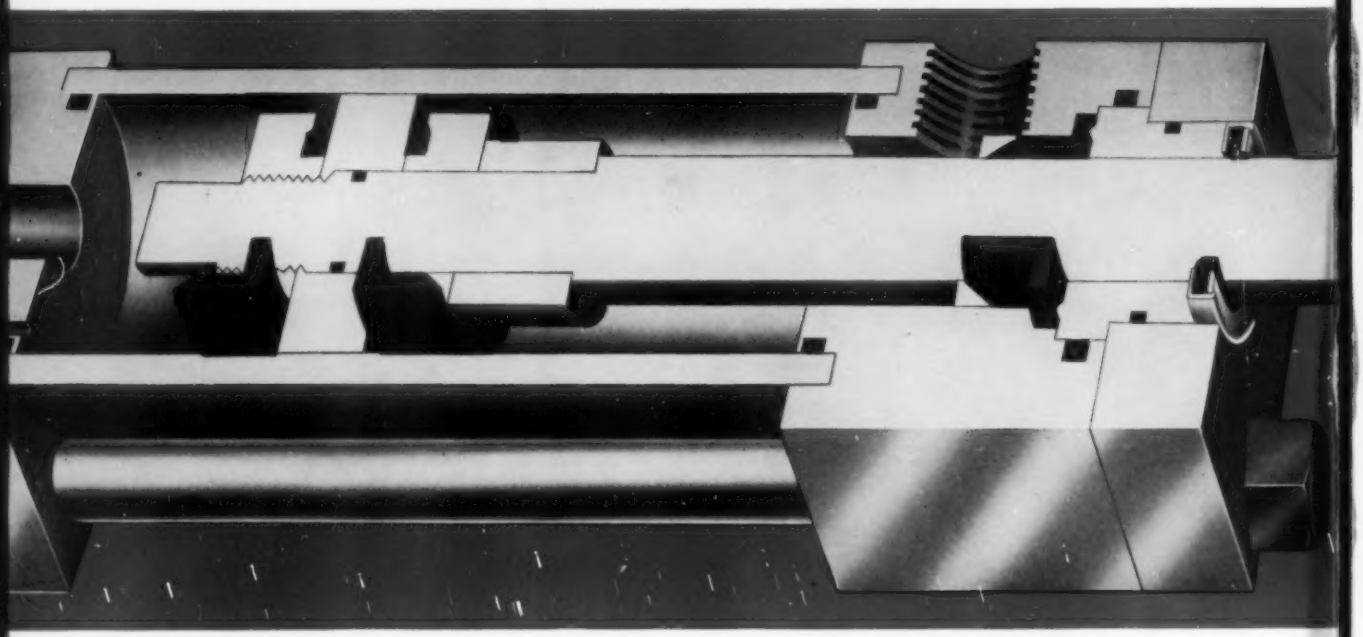
COMPLETE CONTENTS: PAGE 3



Breadboard Servo . . . page 169

conpor

. . . for complete leakage control, greatly increased packing life



Conpor is the first seal and packing material that permits complete porosity control. Undesirable leakage can be eliminated and lubrication adjusted to exact requirements.

Conpor has high tensile strength, flexibility, good abrasion resistance and excellent heat stability. It is compatible with a wide variety of hydraulic fluids, including most of the new non-inflammable types. Standard and special **Conpor** modifications are available for use in solvents (such as aromatics or chlorinated hydrocarbons), gases, various temperature ranges, pressures and cycle speeds. **Conpor** has been used successfully at 8000 psi, although the maximum pressure that can be satisfactorily handled is still undetermined. **Conpor** packings do not score cylinders, do not "chatter" in the most exacting hydraulic systems. Costs are lower originally, in most cases, and *always* lower in service.

Chicago Rawhide engineers will gladly show you how to design for lower costs with **Conpor**.

Send for "Report on Conpor" with full information on this new material. Write: A. S. Berens, Chicago Rawhide Mfg. Co., 900 N. State, Elgin, Ill.

C/R conpor
CONTROLLED POROSITY
SIRVIS MECHANICAL LEATHER

CHICAGO RAWHIDE MANUFACTURING COMPANY

900 North State ELGIN DIVISION Elgin, Illinois

Executive Offices: CHICAGO, ILLINOIS. Representatives in these Principal Cities: Boston • New York • Syracuse • Buffalo • Philadelphia Pittsburgh • Cincinnati • Cleveland • Detroit • Peoria • Minneapolis • Wichita • Tulsa • Houston • Los Angeles • San Francisco • Seattle

Other **C/R** *products*

Oil Seals: Shaft and end face seals for all types of lubricant retention and dirt exclusion • Sirvene (Synthetic rubber) diaphragms, boots, gaskets, and similar parts for critical operating conditions • Sirvis: Mechanical leather packings and related products.

Ross COMET

- *A small, lightning-fast air valve*
- *One moving part—balanced spool*
- *Direct operated four way solenoid valve*
- *Write Dept. 114 for Bulletin 308*

Tomorrow's EnginAIRing Delivered Today

Ross Control

Ross OPERATING VALVE COMPANY

120 E. GOLDEN GATE AVENUE • DETROIT 3 • MICHIGAN

REVERE METALS

SERVE

Chris-Craft

STEM TO STERN

Bending a Revere Copper Tube for use in a Chris-Craft Cruiser. Revere Tube is also used in many Chris-Craft runabouts and utilities

Chris-Craft cruisers are protected at the stem by brass stem bands; Revere supplies half-round extruded shapes for this decorative and protective application. At the stern or transom, copper exhaust tubes are just visible. There is a story behind these tubes, which have to be bent to shape with great accuracy, and without wrinkling. Chris-Craft Corporation's specifications are most exacting. The bending is done by a specialist, the Melville-Lee Co., located in Algonac, Mich., as is Chris-Craft. When Revere sought an order for the copper tube, the Technical Advisory Service was permitted to study Melville-Lee's equipment and methods, so our Methods Department at the mill could be thoroughly informed of the high quality requirements.

The tube required runs in sizes from 2" to 3½" OD. Use of copper tube reduces weight, while the corrosion-resisting qualities of copper make it durable and long lasting. Special standards of control over roundness, eccentricity and temper were set up in our mill, and production shipments have worked perfectly from the very beginning. No wrinkling or tearing has been encountered.

• • •

Revere Metals not only serve afloat, but in the air, under the sea, and on land, in almost every industry, including such diverse ones as the chemical, automotive, electrical and electronic, and in the home. Products include tube and pipe, rod and bar, sheet and plate, strip, extruded shapes, forgings, in copper and its alloys and aluminum alloys. Also Lockseam Tube electric welded steel tube. Get in touch with the nearest Sales Office.

REVERE

COPPER AND BRASS INCORPORATED

Founded by Paul Revere in 1801

230 Park Avenue, New York 17, N.Y.

• • •

Mills: Baltimore, Md.; Chicago and Clinton, Ill.; Detroit, Mich.; Los Angeles and Riverside, Calif.; New Bedford, Mass.; Rome, N.Y. —Sales Offices in Principal Cities, Distributors Everywhere

SEE "MEET THE PRESS" ON NBC TELEVISION, SUNDAYS

Product Engineering

SEPTEMBER, 1954

Volume 25 Number 9

Constant Force Compression Springs ..... Edwin H. Boerner 129

Aluminum Hard Coatings ..... Henry A. Johnson 136

Product Designs 142

Flexible Epoxy Plastics ..... J. S. Jorczak and D. Dworkin 154

Rubbing Seals for Oil Retention ..... David C. Spaulding, Jr. 158

Compression Terminals for Aluminum Conductors .... J. Redslob 160

Effects of Finishing on 75S-T6 Aluminum Alloy ..... M. J. Brown 163

Plaster Casting the Light Metals ..... George R. Gardner 164

Mechanical Components for Automatic Control ... Sidney A. Davis 169

Gearing: effect on system performance; selection of ratios; gear design and backlash. Clutches: hysteresis, eddy current, magnetic, magnetic fluid; linearity characteristics and control circuits. Mechanical elements: base plates, hangers, couplings, stops, dials and terminal blocks for servo construction.

Wheatstone Bridge Charts ..... Wayne A. Ring 209

Highlights	5	New Parts and Materials .	216	Sans, Souci	323
Design Perspectives ...	123	New Catalogs and		Engineering Abstracts .	325
Editorial	127	Bulletins	305	News Books	331
Technical News	201	Meetings	322	Readers Letters	338

Product Engineering

SEPTEMBER, 1954 VOL. 25, NO. 9

THE McGRAW-HILL MAGAZINE OF DESIGN ENGINEERING

Member of Associated Business Publications and Audit Bureau of Circulations

Published monthly by McGraw-Hill Publishing Company, Inc., James H. McGraw (1860-1948), founder. **Publication office, 99-129 North Broadway, Albany 1, N. Y. Executive, Editorial and Advertising Offices: McGraw-Hill Building, 330 W. 42nd St., New York 36, N. Y.** Donald C. McGraw, President; Willard Chevalier, Executive Vice-President; Joseph A. Gerardi, Vice-President and Treasurer; John J. Cooke, Secretary; Paul Montgomery, Executive Vice-President, Publications Division; Ralph B. Smith, Vice-President, Editorial Director; Nelson Bond, Vice-President, Director of Advertising; J. E. Blackburn, Jr., Vice-President, Circulation Director.

Subscriptions: Product Engineering—Subscription Service, 99-129 N. Broadway, Albany 1, N. Y., or 330 W. 42nd St., New York 36, N. Y. Allow one month for change of address.

Subscriptions are solicited only from executives, engineers and consultants engaged in the design of machinery and other engineered products. Position and company connection must be indicated on subscription orders.

Single copies 50¢. United States and possessions, $5 for one year, $8 or two years, $10 for three years; Canada, $6 for one year, $10 for two years, $12 for three years; other Western Hemisphere and the Philippines, $15 for one year, $25 or two years, $30 for three years; all other countries, $25 for one year, $40 for two years, $50 for three years. Entered as second class matter Aug. 21, 1936, Albany, N. Y. Post Office, under act of Mar. 3, 1879. Printed in U. S. A. Copyright 1954 by McGraw-Hill Publishing Co., Inc. —All rights reserved.

Number of copies printed this issue 31,828

THIS MONTH'S COVER

Complex computing servomechanism, typical of those used in automatic control applications, set up exclusively with standard electrical and mechanical components. Components available for designing such breadboards are described in "Mechanical Components For Automatic Control", which starts on page 169 of this issue.

THE STAFF

Editor
GEORGE R. NORDENHOLT

Assistant to the Editor
JOSEPH KERR

Managing Editor
ROBERT W. CARSON

Associate Editors
JOHN ALICO
EDWARD S. COBB
RANDOLPH P. DOMINIC
ELMER T. EBERSOL, Jr.
JAMES R. McDERMOTT

Assistant Editors
ROBERT E. ABBOTT
PAUL N. ANDERSON
ROBERT W. BRULEY
JOHN KOLB
NORMA J. VAN NESS

Editorial Assistant
LILLIAN M. WITHAM

Consulting Editor
ROBERT E. BRUCKNER

Washington
GEORGE B. BRYANT, Jr.

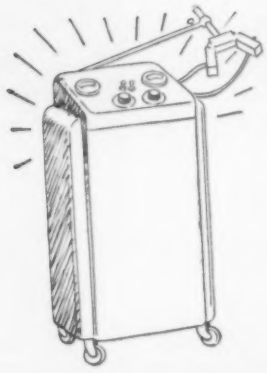
Publisher
ALBERT HAUPTLI

Advertising Sales Manager
STANLEY J. ALLING

Service Manager
HUGH BRITTON

Foreign News Bureaus:
LONDON • PARIS • BERLIN
SYDNEY • TOKYO
MEXICO CITY
FRANKFURT • SAO PAULO
BUENOS AIRES • MANILA

The case of the disturbing diathermy machine



A doctor's diathermy equipment was ruining television reception in his neighborhood. He had a complete electrical shield built around the room where the equipment was located, but the interference persisted.

SOLVED by Mallory Noise Filters

A feed-through filter supplied by Mallory ended the problem. Rated at 50 amperes, 330 volts AC, it consisted of three sections like the one illustrated—all contained in a compact case, and connected in series with the three-phase power supply. It provided high attenuation throughout an unusually wide range: over 100 db from 6 to 400 megacycles, and better than 90 db from 400 to 1000 megacycles. It stops interference in both the VHF and the new UHF television bands . . . allows good reception as close as twenty feet from the equipment!

Does your product need noise suppression? You can count on Mallory for the specialized skills essential to designing noise suppression for today's increasingly exacting specifications. At your service is our extensive experience in engineering and manufacturing noise filters for every commercial and military requirement. Write or call us today.

Expect more . . .

Get more from **MALLORY**

Serving Industry with These Products:

Electromechanical—Resistors • Switches • Television Tuners • Vibrators
Electrochemical — Capacitors • Rectifiers • Mercury Batteries
Metallurgical—Contacts • Special Metals and Ceramics • Welding Materials

P.R. MALLORY & CO. Inc.
MALLORY
P. R. MALLORY & CO., Inc., INDIANAPOLIS 6, INDIANA

Highlights

When requesting further information from companies and organizations mentioned in the items below, confusion can be avoided by referring to the issue of Product Engineering in which items appear. These items represent current research and design developments soon to influence product engineering.

METALLIC MATERIALS

....Metal sandwich is being used to stop the oxidation of molybdenum and tungsten when used in jet engines or gas turbines. The metals are sandwiched in aluminum and can withstand temperatures as high as 3,600 F according to Whitfield and Sheshunoff, Inc., 2 Harvard St., Garden City, N. Y. Both metals oxidize in air so rapidly that part life expectancy does not exceed 300 hr. Hot dipping the alloys in molten aluminum applies a protective jacket that guards against oxidation at high temperatures.

MINERAL FIBERS . . . .

....can be produced from various ores—excluded are iron, nickel and other heavy metals—by a technique developed at the Tohoku University, Sendai, Japan. Materials, such as basalt and aqueous rock, having a melting point of over 1,800 C, arc melted down. Liquid is poured on a slit revolving disk and fiber is formed through centrifugal force with the aid of a current of air. It is believed that the addition of the fiber to cement will make it 10 times stronger than steel. Further processing—into polyester resin—could strengthen the fiber to make it usable for aircraft wings and bodies in place of light metals.

ATOMIC POWERPLANTS . . . .

....are visualized as being run on liquid metals which will supply fuel, control the reaction, and transfer the heat out to where it can be used. Research at Brookhaven National Laboratory, Brookhaven, L. I., N. Y., indicates that uranium and thorium will be dissolved in other and lighter metals, such as lead, bismuth and tin. Studies are being made to work out a method whereby the liquids would clean themselves of the debris of the atomic reaction. Metals would be handled in the reactor at about 500 C. Another possibility: sodium hydroxide—costly when in an anhydrous form—can probably be used in a liquid state.

MOLYBDENUM . . . .

....applied by the metallizing process has markedly different characteristics than the wrought material. According to the Metallizing Engineering Co., 38-18 30th St., Long Island City 1, N. Y., it provides a uniform bonding coat for the application of other sprayed metal coatings and insures better heat transfer and greater freedom from voids. Sprayed molybdenum coatings have excellent wear qualities. Example: textile spindles sprayed with molybdenum last 3 to 5 times longer than chrome plated spindles. Press fits can also be restored by spraying with molybdenum the rotating shaft.

STEEL RIBBON . . . .

....and nylon cord are being introduced in conveyor belts and is reported to lengthen belt life by as much as 50 per cent. B. F. Goodrich, 448 S. Main St., Akron, Ohio report that the steel is inserted crosswise at 3 ft intervals. The ribbons are claimed to stop full length slashes that occur when sharp objects jam and rip the moving fabric. Run lengthwise, the nylon cord resists snags and adds strength to the conveyor belt.

NONMETALLIC MATERIALS

....Paint that resists peeling, when aircraft are flown at supersonic speeds, is under development for the Royal Air Force by Cellon Ltd., Richmond Road, Kingston, Surrey, England. Based on epoxy-type plastic resins, a smooth aerodynamic finish is produced which may increase flight speeds by 20 mph. It is reported to withstand temperatures up to 400 F and resists attack by jet fuels, lubricants and hydraulic fluids. Used with a lightweight primer, two coats will yield, it is claimed, adequate protection against peeling.

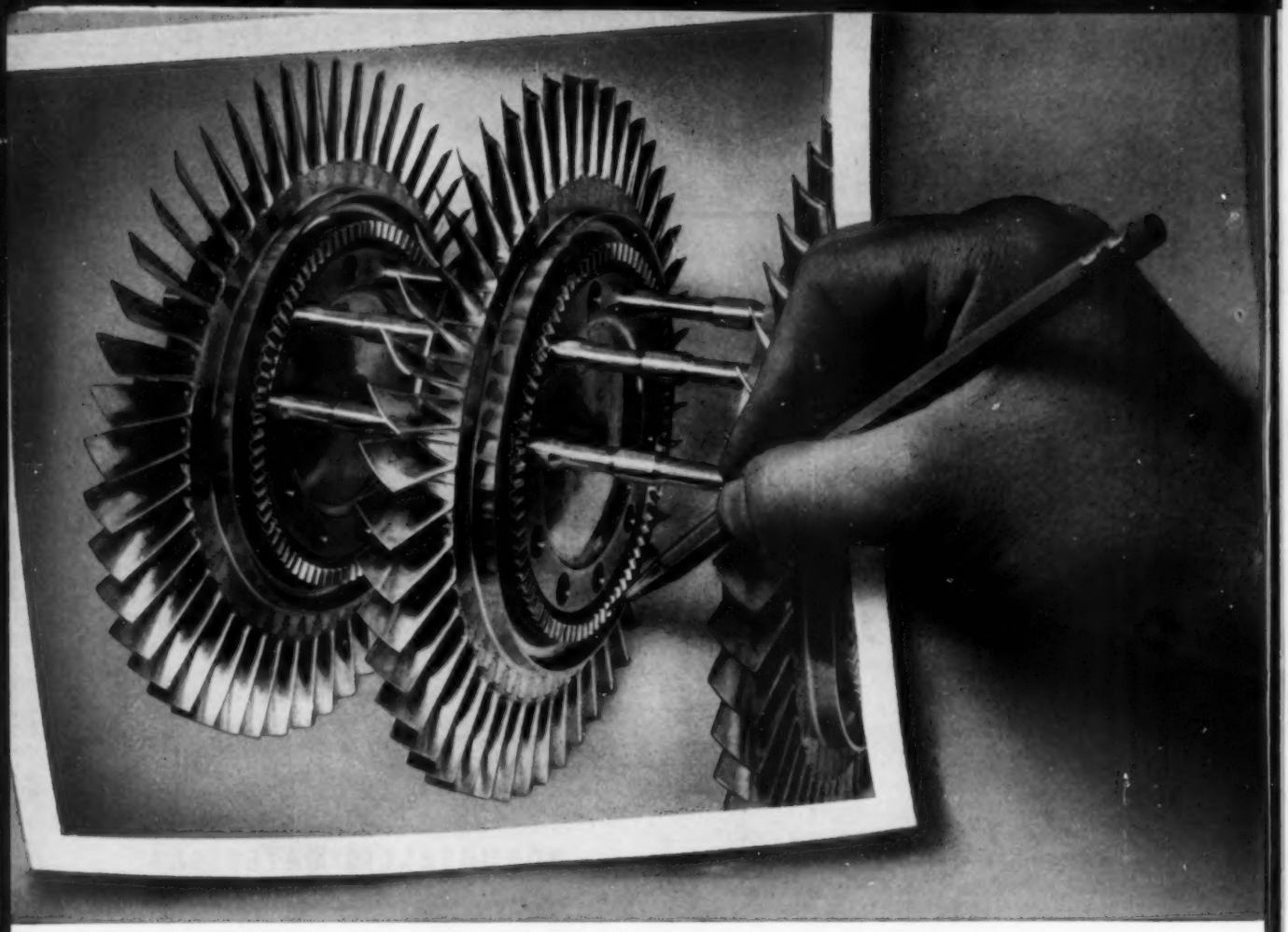
SILICONE . . . .

....has another new use. It is being tested as a mold release agent in the manufacture of bottles by the General Electric Co., 1 River Road, Schenectady, N. Y. Reports indicate that it prevents hot bottles from sticking to metal molds, hence facilitating easy and safe removal. Probably more important: the silicone overcomes smoke and fire hazard created by conventional combinations of oil and chemicals used as bottle release agents. Further: the company reports that the silicone emulsion is being sprayed over machinery to reduce fire hazards caused by oil deposits.

WET STRENGTH . . . .

....and abrasion resistance is considerably increased through use of a new technique of impregnating paper. Developed by the Shoe Products Div., Dewey and

(*continued on page 7*)



Can CURVIC® Couplings lower the cost of your product?

They have done so for scores of manufacturers, by reducing machining time, by saving time in assembly and by permitting more compact design.

CURVIC Couplings are extremely accurate toothed connections which combine the functions of driving, centering and alignment.

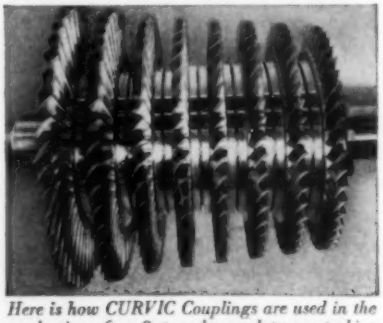
With CURVIC Couplings, complex machine parts can be made in several smaller units and then bolted or otherwise fastened together. Experience has proved that fabrication of many large parts in smaller units has reduced the time spent in machining, simplified final assembly, and reduced over-all manufacturing costs.

And there is no sacrifice of precision—in fact, CURVIC Couplings are so accurate that tolerances in the finished assembly can be held closer than when the part is made by any other means.

CURVIC Couplings are used in such applications as heavy-duty gas turbine rotors like the one shown above, jet engines, crankshafts and camshafts.

In addition to fixed or permanent connections, CURVIC Couplings can be produced in semiuniversal, and in releasing clutch types.

All types of CURVIC Couplings are produced rapidly, economically, and with high precision, on Gleason Cutting and Grinding Machines. If you would like to know more about CURVIC Coupling design or manufacture, the Gleason Works will be glad to consult with you, and to make recommendations about your specific applications. Write for our booklet.



Here is how CURVIC Couplings are used in the production of an 8-stage heavy-duty gas turbine rotor, holding it in perfect alignment under the severe stresses encountered at high speed.

GLEASON WORKS

Builders of bevel gear machinery for over 85 years

1000 UNIVERSITY AVE., ROCHESTER 3, N. Y.

Highlights

Almy Chemical Co., 62 Whittemore Ave., Cambridge, Mass., it is claimed, that when the synthetic elastomers and resins are used any thickness of paper can be treated. Tests indicate that the paper retains 90 per cent of its tensile strength after soaking and has more than 10 times the abrasion resistance of paper impregnated by ordinary methods.

TWO NEW COMPOUNDS . . . .

. . . .have been developed for the adhesive bonding of metal to metal and metal to plastic Developed by the Rubber and Asbestos Corporation, 225 Belleville Ave., Bloomfield, N. J., one adhesive is for normal temperature use and the other for high temperature applications. Designation M615 is reported to have a shear strength of 3,500 psi and exceptional impact strength at room temperature. M616, provides shear strength up to 3,000 psi at 180 F and 1,500 psi at 300 F. Good flexibility is claimed at high temperature.

SILICONE RUBBER ADHESIVE . . . .

. . . .which sets up without pressure in 24 hr at room temperature is reportedly used to bond silicone rubber to itself or to aluminum, magnesium, stainless steel, butyl or saran rubber. Dow Corning Corp., Midland, Mich., states that maximum bond strength is developed within 3 to 7 days. Peel strength is 15 psi between extruded Silastic and aluminum and 9 psi with molded silicone rubber. Heat and creep resistance are good up to 100 C once the adhesive has set.

PROCESSES

. . . .Continuous casting of ingots of aluminum and magnesium by a new technique is said to eliminate faulty ingots that are often produced by the older methods. Alcoa, 1200 Alcoa Bldg., Pittsburgh 19, Pa., reports that the molding technique permits many ingots to be cast at once, slowly withdrawing them as the metal hardens. Molten metal is siphoned from a master reservoir into individual molds in proportion to the speed at which the hot ingot emerges. Siphons permit the molten metal to flow into the molds smoothly without carrying air which can oxidize the metal.

ANTI-STATIC AGENT . . . .

. . . .which, it is claimed, will eliminate or greatly reduce the processing difficulties caused by friction-formed static electricity has been developed by E. F. Houghton and Co., 301 W. Lehigh Ave., Philadelphia 33, Pa. It is reported exceptionally useful on synthetic fibers—except acetate and blends—and can also be used for natural fibers. Agent is a water soluble liquid and forms a semi-transparent solution when made up for use. It can be used in conjuction with processing oils or stock lubricants.

AIRCRAFT PARTS . . . .

. . . . have been hot extruded from titanium with good surfaces and satisfactory tolerances. Lockheed Aircraft Corp., 2555 N. Hollywood Way, Burbank, Calif., and Harvey Machine Co., Inc., 19200 S. Western Ave., Torrance, Calif., state that the cost savings of such hot extrusions are appreciable. Indications are that the die configuration controls the flow of metal into and through the extrusion orifice and determines ease of flow, retention of lubricant, extrusion tolerance and die life. Titanium, it is claimed, extrudes better than steel, the die fills better, surface finish is satisfactory and die wear is less. Dimensional tolerances are claimed to be comparable to those of hard aluminum alloy extrusions.

TITANIUM SHEET . . . .

. . . .when protected by gas shielding during welding, can be production welded according to The Glenn L. Martin Co., Baltimore, Md. Argon is used to shield the molten weld puddle while helium is used for backing up or in a chamber. Tubular sections welded in this way have withstood pressures up to 600 psi before rupturing in the weld—well above other methods.

WELDING. . . .

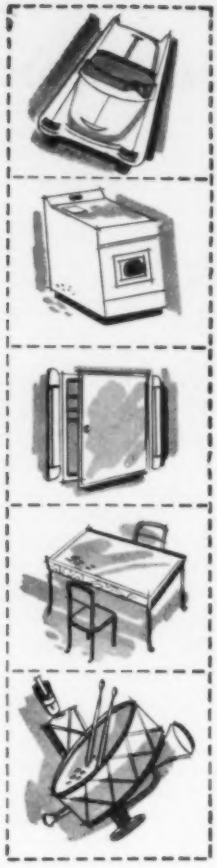
. . . .of commercial titanium alloys is possible but special techniques and heat treatment after welding to reduce embrittlement is required. Mallory-Sharon Titanium Corp., Niles, Ohio, reports that arc welding is difficult because of contamination by air and is not yet commercially practicable. Helium or argon provide a suitable inert atmosphere but shielding is necessary and back cooling with trailing gas shields is also essential. Spot welding is easy and gas protection is unnecessary. Flash welding—if overheating is avoided—is feasible, but embrittlement will result unless air is excluded during the welding process.

CHEMICAL MILLING. . . .

. . . .may replace the machine milling of aluminum from sheet and forging stock by a process developed jointly by North American Aviation, Inc., International Airport, Los Angeles, Calif., and Turco Products, Inc., 61 St. and S. Central Ave., Los Angeles, Calif. The process: material to be removed on a part is exposed while the rest is masked with a specially developed coating. Part is then submerged in an etching solution which attacks the exposed metal at a constant rate. The results: finished metal surfaces to accuracies of 0.002 in. The process is electronically controlled. Although the experimental work has been on aluminum, it is believed applicable to steel and titanium. If so, machining cost of components in aluminum, steel and titanium should be substantially reduced.

(*continued on page 9*)

LESSON IN STAYING PUT



and Bonderite Makes Paint Stay Put on Metal

Paint doesn't stay put when applied to raw metal surfaces. But the same metal, treated with Bonderite, holds paint firmly.

Bonderite, Parker's corrosion resistant paint base, creates a tight phosphate coating, integral with the treated metal. The smooth, even coating provides a firm anchor for paint, resists corrosion and stops the spread of rust around scratches and breaks in the painted surface.

Literally thousands of metal products on the market today are protected with Bonderite. Automobiles, household appliances, business machines, metal furniture, electrical equipment, toys, and sewing machines are among the products treated with Bonderite. And their fine finishes last longer because of it.

Your painted metal products should have the added value, the added sales appeal, of Bonderite under the paint. Write today for full information!

**Bonderite—Reg. U. S. Pat. Off.*

PROTECTED BY Bonderite QUALITY CORROSION RESISTANT

Since 1915—leader in the field

PARKER RUST PROOF COMPANY

2179 E. Milwaukee, Detroit 11, Michigan

BONDERITE	BONDERITE and BONDERLUBE	PARCO COMPOUND	PARCO LUBRITE
corrosion resistant paint base	aids in cold forming of metals	rust resistant	wear resistant for friction surfaces

Highlights

COMPONENTS

. . . . Disk brakes operating on the ball and ramp principle may be the answer for automotive brakes since cars continue to gain weight and develop greater inertia. Developed by the Auto Specialties Mfg. Co., St. Joseph, Mich., the brake consists of two power actuating disks, back to back. Linings are bonded to their outer surfaces. Hydraulic actuation forces the disks apart and against the braking surfaces of the housings. The balls —in the ball and ramp mechanism—roll up the ramps, creating self-energization.

FILTER ELEMENT . . . .

. . . . made of porous stainless steel for airborne hydraulic service is a development of Aircraft Porous Media Inc., 31 Sea Cliff Ave., Glen Cove, L. I., N. Y. Elements are made from Type 316 steel and can be used in operation at temperatures over 600 F. Elements are graduated to remove particles in 2, 3, 7, 12 or 22-micron sizes. Low pressure drop and long service life are claimed for the filter elements.

COMPRESSION SEAL . . . .

. . . . from a new material of high resilience can take extremes of temperature from subzero to extremely hot. Arrowhead Rubber Co., 2348 Corry St., Long Beach, Calif., reports the seal is resilient, flexible and has a temperature range from —125 to 300 F. Another type: designed for extreme abrasion resistance, will withstand variations within the same limits.

MOLDED NYLON PARTS . . . .

. . . . which do not break down under ultraviolet radiation—thus can be used for outdoor applications—have been developed by E. I. du Pont de Nemours & Co., Inc., Wilmington 98, Delaware. New formulation shows promise for possible use in agricultural machinery, electrical equipment and automobiles.

TESTING

. . . . A journal bearing oil film temperature measuring change device has been tested that should increase the reliability of operation for turbines and reduction gearing. The Navy Department, Office of Information, Washington, D. C., reports that oil temperature measurements can be taken at the point of origin of the heat with thermocouples. Conventional method: measuring bearing lubrication oil discharge temperature at the combined sight flow and thermometer fitting.

TITANIUM FASTENER TESTS . . . .

. . . . on nuts, bolts, screws, rivets and elastic stop nuts indicate that although these items can be used, some manufacturing difficulties must still be overcome. Airborne Equipment Div., Bureau of Aeronautics, Navy Dept., Washington, D. C. reports that a better lubricant is needed to reduce galling during machining and working. Coating threads with Teflon does tend to reduce galling. Cold working, around bends, fillets and threads is indicated for better fatigue properties. Above all: a more uniform product is required.

ELECTRICAL TEST CLIPS . . . .

. . . . with flexible jacket-type insulators are being molded of Bakelite vinyl compounds that resist the effects of constant wear. Mueller Electric Co., 1555 East 31 St., Cleveland 14, Ohio, reports that the high dielectric strength of the vinyl compounds provide protection against shock when connecting electrical circuits. Low wearing qualities are based on the vinyl compounds retention of electrical insulating value even after contact with most greases, oils and acids.

AUTOMATIC EQUIPMENT . . . .

. . . . tools, unloads and transfers automobile camshafts between a pair of coupled lathes. The machine—designed by the Seneca Falls Machine Co., Seneca Falls, N. Y.—turns out 112 camshafts per hr.

SILICON RECTIFIER . . . .

. . . . is said to have an efficiency of about 98 percent. Also, according to Westinghouse Electric Co., P. O. Box 868, Pittsburgh 30, Pa., the experimental unit is capable of delivering more than 1,200 watts—most available units generally produce less than 1 watt.

NEW ELEMENTS. . . .

. . . . are expected to be formed by using heavier bombarding particles— such as beryllium and neon—in the recently authorized linear accelerators for Yale University, New Haven, Conn., and the University of California, Burbank, Calif. Heavier bombarding particles, it is believed, have a better chance of being added to the nucleus of an atom like uranium, than have repeated additions of light particles such as hydrogen and helium. Changes to the weight of the atom should produce a variety of new element forms.

UNIVERSAL TESTING INSTRUMENT. . . .

. . . . that measures 20 in. by 45 in. and is 42 in. high, is a development of The Instrom Engineering Corp., 2 Hancock St., Quincy 71, Mass. The instrument records stress-strain curves in tension or compression. Electronic load weighing system permits full scale loads from 10 gm to 100 lb. Crosshead is driven synchronously through fast-acting magnetic clutches and change gears, providing a choice of test speeds.

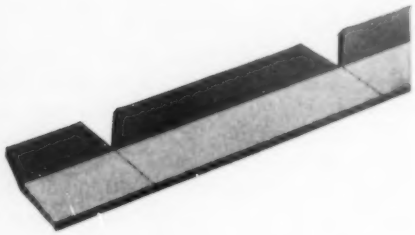
Pedestal Poles and Base Covers made from **Cold-Formed Shapes**

In making these sturdy, long-lasting sign supports, we cold-form tapered channels 12 ft long from 10-gage sheets, then machine-weld the two channels together to form the rectangular pole.

The base cover is also cold-formed from 10-gage sheet steel. It consists of two halves which are bolted together by means of angle clips welded inside.

Bethlehem is fully equipped to turn out jobs like this in almost any quantity. What's more, these poles are only one of literally hundreds of parts and products we've formed, and in some instances, fabricated for such diverse uses as overhead-door track, guy-wire guards, storage racks and lawn-mower parts.

Bethlehem Cold-Formed Shapes are regular or irregular shapes formed cold from strip, sheet or plate steel. They are uniform in thickness and have a high strength-to-weight ratio. We make them



on presses, brakes or rolls, in all gages from 5 to 24.

Perhaps you have an idea which could be developed into a practical, cost-cutting use for cold-formed shapes. Tell us about it. Write direct to us at Bethlehem, Pa., including, if possible, a rough sketch of the part you have in mind.

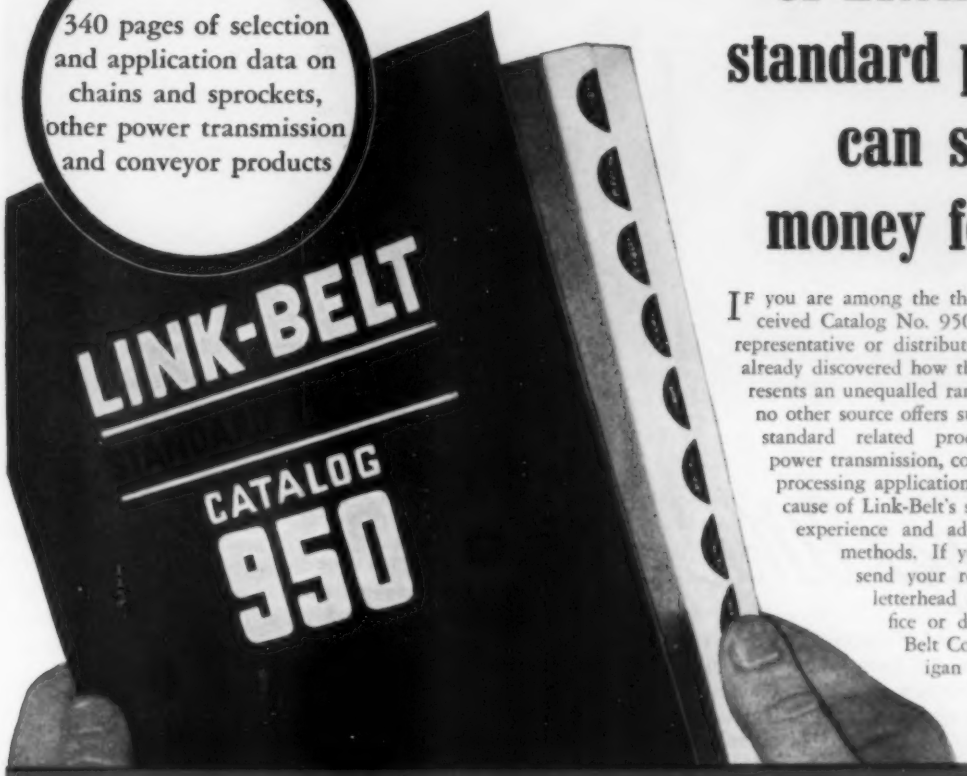
BETHLEHEM STEEL COMPANY
BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. *Export Distributor:* Bethlehem Steel Export Corporation

BETHLEHEM STEEL

How this NEW catalog of LINK-BELT standard products can save money for you

340 pages of selection and application data on chains and sprockets, other power transmission and conveyor products

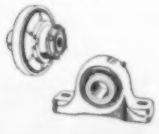


IF you are among the thousands who have received Catalog No. 950 from your Link-Belt representative or distributor, chances are you've already discovered how this "encyclopedia" represents an unequalled range of choice—because no other source offers such a complete line of standard related products for mechanical power transmission, conveying, elevating and processing applications. You profit, too, because of Link-Belt's specialized engineering experience and advanced manufacturing methods. If you don't have a copy, send your request on your firm's letterhead to your Link-Belt office or distributor or to Link-Belt Company, 307 N. Michigan Ave., Chicago 1, Ill.

Here's a single, easy-to-use source for all these quality products

Chains—cast, combination, forged and steel sidebar and attachments, with arm or plate center cast sprockets. *Precision steel roller chains and sprockets. Silent chains and sprockets.* Castings, tighteners, wing and swivel attachments.

Enclosed drives—P.I.V. variable speed and fluid drives, gearmotors and motogears, parallel shaft and worm gear drives.



Bearings—ball, roller, babbitted and bronze. *Rigid and flexible couplings.* Take-ups, hangers, bushings, pulleys, gears, clutches, backstops, shear pin hubs, collars, grease cups.

Processing equipment—vibrating screens, icing equipment.

Conveyors—Flexmount oscillating and piano-hinged apron. *Components* for screw, belt and trolley conveyors. *Car spotters and pullers. Power unloading scoops. Bucket elevators and elevator buckets.*

Other products—cast and cut tooth sprocket wheels, taper lock bushings, spray nozzles, gates, cutoff valves, winches.

LINK-BELT

One source . . . one responsibility for materials handling and power transmission machinery

LINK-BELT COMPANY: Executive Offices, 307 N. Michigan Ave., Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices, Stock Carrying Factory Branch Stores and Distributors in All Principal Cities. Export Office: New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World. 13,050

DIE CAST OF ZINC

for WEBCOR

Here's Why....

The engineers of Webster-Chicago have one aim in their industrial lives—to provide high fidelity sound reproduction at a price which will assure wide market appeal for every instrument in the Webcor line. To achieve this objective in their three-speed HF phonographs, the eight odd-shaped ZINC Die Cast components shown below are employed in several models. Of these, the above tone arm-rest housing best illustrates the physical and economic advantages gained.

Metal Saving—Since the cost of any product is influenced by the amount of material consumed, it should be noted that the above housing (as shown from the underside) has been ingeniously cored—*in the casting operation*—to eliminate all unnecessary metal, and no metal need be removed and wasted in secondary operations. This metal saving is accomplished with no sacrifice of strength since cross ribs are judiciously located at points of stress.

Labor Saving—The housing and the other ZINC Die Castings have made possible a compact phonograph mechanism with an absolute minimum number of parts. When such complexity of shape can be achieved, one part can be made to serve in place of several. This, together with the accurately located cast bosses, makes for trouble-free assembly at the lowest possible cost. A further labor saving results from the smooth as-cast surfaces of the parts which easily receive and hold handsome, durable coatings.

For further examples of successful product engineering with ZINC Die Castings ask us—or any die casting company—for a copy of "The End Uses of Zinc Die Castings."

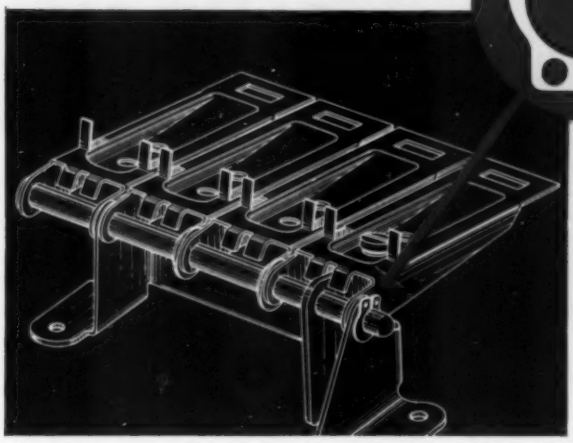
The New Jersey Zinc Company
160 Front St., New York 38, N. Y.

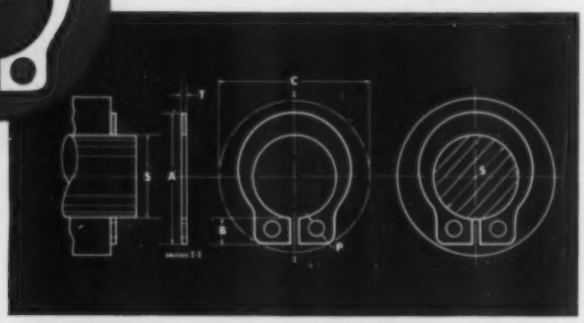
ZINC
FOR DIE CASTING ALLOYS

The Research was done, the Alloys were developed, and most Die Castings are based on

HORSE HEAD SPECIAL (99.99 + % Uniform Quality) ZINC

New Waldes Truarc GRIP Ring requires no groove, holds fast by friction, can be used over and over again





Ring # 5555		5555-12	5555-13½	5555-18	5555-25	5555-31	5555-37
SHAFT DIAMETER	Fract. Equiv. S	1/8"	—	3/16"	1/4"	5/16"	3/8"
	Dec. Equiv. S	.125	.136	.187	.250	.312	.375
	TOL.	±.002	±.002	±.002	±.002	±.003	±.003
RING DIMENSIONS	Thickness T	.025	.025	.035	.035	.042	.042
	TOL.	±.0015	±.0015	±.002	±.002	±.002	±.002
	Length A	.268	.285	.364	.437	.553	.626
	Lug B	.078	.078	.097	.097	.141	.141
	Hole P	.042	.042	.042	.042	.078	.078
	Min. Ring Clear C	.33	.34	.44	.50	.67	.73
Approx. Ultim. Thrust Load (Lbs)		20	20	25	35	50	60

The Waldes Truarc Grip Ring is a new, low cost fastener that provides a positioning shoulder secure against moderate thrusts or vibration. Installed on a straight ungrooved shaft, the Truarc Grip Ring can be assembled and disassembled in either direction with Truarc pliers.

The Grip Ring can be installed tightly against a machine part in order to take up end-play. The basic Truarc design principle assuring complete circularity around periphery of the shaft and the ring's unusually large radial width combine to exert considerable frictional hold against axial displacement. The ring can be used again and again.

Find out what Waldes Truarc Retaining Rings can do for you. Send us your drawings. Waldes Truarc engineers will give your problems individual attention without obligation.

SEND FOR NEW CATALOG

WALDES

TRUARC

REG. U. S. PAT. OFF.

RETAINING RINGS

WALDES KOHINOOR, INC., LONG ISLAND CITY 1, NEW YORK

WALDES TRUARC RETAINING RINGS AND PLIERS ARE PROTECTED BY ONE OR MORE OF THE FOLLOWING U. S. PATENTS: 2,362,047; 2,392,940; 2,410,552; 2,420,921; 2,428,361; 2,439,765; 2,441,848; 2,455,195; 2,483,300; 2,483,303; 2,487,002; 2,487,803; 2,491,304; 2,509,081 AND OTHER PATENTS PENDING.

Waldes Kohinoor, Inc., PN-096
47-16 Austel Place, L.I.C. 1, N. Y.

☐ Please send me sample Grip-Rings (please specify shaft size _____)

☐ Please send me the complete Waldes Truarc catalog.

(PLEASE PRINT)

Name_____

Title_____

Company_____

Business Address_____

City_____ Zone____ State_____

MAXITORQ
Overload Release
CLUTCH

protects against conveyor overload

FOR THE LAMSON CORPORATION

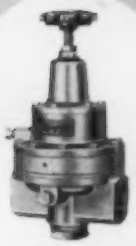
This prominent Syracuse, N. Y., manufacturer of materials handling equipment has selected the Maxitorq Overload Release Clutch for power transmission on its drive unit for the Lamson overhead conveyor. On installations which handle heavy loads the cam design feature automatically causes instant disengagement of the clutch when the overload is substantially greater than the normal driving load . . . thus preventing damage to product and machine.

The Overload Release Clutch has all of the highly favored features of the standard Maxitorq floating disc clutch . . . Separator springs that keep discs "floating" in neutral . . . no drag, no abrasion and, consequently, no heating in neutral. Assembly, adjustment and take-apart are made without use of tools. Engagement is easily controlled, with light pressure. Disengagement is instant and complete.

There are six capacities, ¼ to 5 h.p. at 100 r.p.m. Maximum working torque from 13 to 263 ft. lbs. There are so many varied applications of this Overload Release Clutch that we suggest submitting your clutch problems to our engineering department for practical recommendations. In other words, "let's talk Maxitorq."

SEND FOR CATALOG NO. PE-9

THE CARLYLE JOHNSON MACHINE COMPANY
MANCHESTER • CONNECTICUT

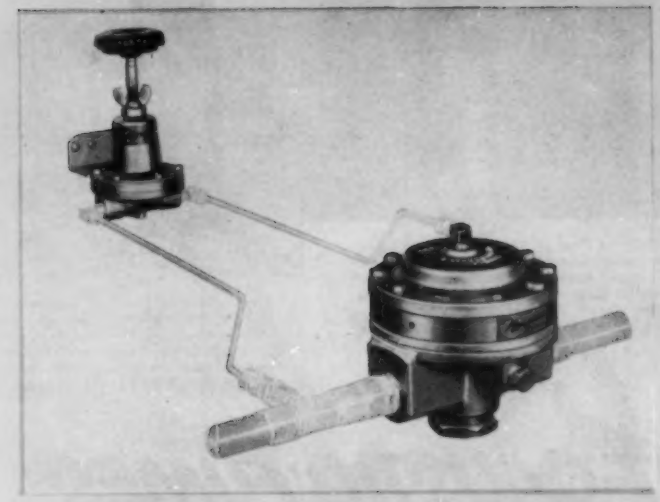


Norgren
Pilot-Controlled
Regulator
Integral
Type

Norgren

PILOT-CONTROLLED PRESSURE REGULATORS

give you greatest performance for cost and size



Norgren
Pilot-Controlled
Regulator,
Remote Control Type

MORE CAPACITY — MORE ACCURACY

Norgren Pilot-Controlled Pressure Regulators provide extremely accurate, automatic pressure regulation, with capacities up to 250 cfm (more if needed). Performance data prove that large fluctuation in flow and primary pressure have negligible effect on regulated air pressure. Examples: the secondary pressure remains constant at 30 psi. with an 80 psi. primary pressure and flow varying from 0 to 200 cfm. Secondary pressure remains constant at 30 psi. with flow of 60 cfm. with primary pressure varying from 50 to 120 psi.

Using accurately controlled air pressure for your pneumatic equipment is essential if you want a higher quality of machine output at a faster rate of production and at lower unit costs. You'll find, too, that important savings in equipment maintenance and in compressed air costs often result.

MAXIMUM FLEXIBILITY

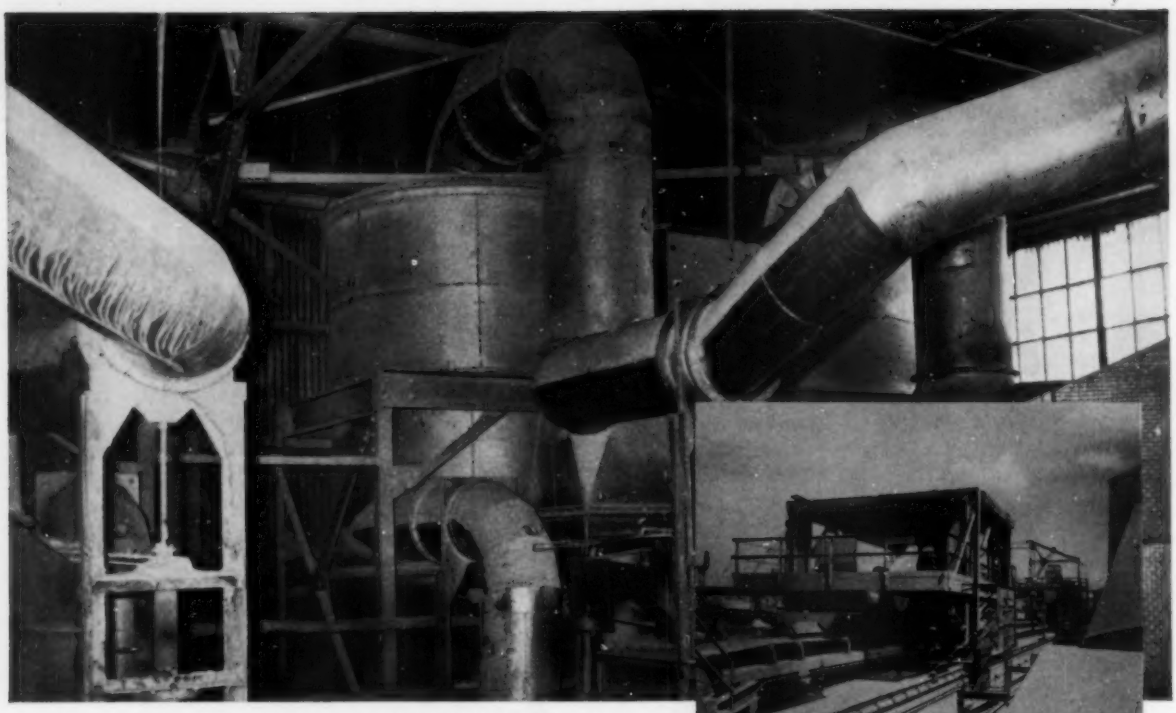
Norgren Pilot-Controlled Air Regulators are available in both remote control and integral types; ½", ¾", 1" sizes; for the accurate reduction of line pressures as high as 400 psi. to working pressures of 2 to 120 psi; capacities up to 250 cfm. (more if needed).

WRITE FOR COMPLETE DATA

C. A. Norgren CO.
3428 SO. ELATI ST., ENGLEWOOD, COLO

PIONEER AND LEADER IN OIL-FOG LUBRICATION FOR 26 YEARS

VALVES • FILTERS • LUBRICATORS • REGULATORS • HOSE ASSEMBLIES



These flues and dust collectors are part of the refining plant of Aluminum Co. of America, at Mobile, Ala., where alumina is separated from bauxite. Furnace temperatures in the plant subject interior equipment to 350°F. heat; caustic dust and fumes are severe. Despite these rough conditions, paint on the interior equipment is in good condition and has been renewed only once since 1938. A formulation based on BAKELITE Phenolic Resins, pigmented with aluminum, is used and, according to the plant superintendent, "lasts better than anything they have found."

Aluminum paint based on BAKELITE Phenolic Resins also keeps this refinery's exterior equipment in excellent condition. A new coating is given about every five years. Of course, the same formula is used. Coatings for both interior and exterior work were formulated by **Mobile Paint Mfg. Co., Inc.**, Mobile, Ala.

350°F. HEAT-CAUSTIC FUMES

and equipment coating that really stands up

If you wish to provide buildings, equipment, or products with long-lasting protection against corrosives, temperature extremes, industrial atmosphere, and hard usage, there are many specialized coatings based on BAKELITE Resins available from coating formulators. Results in just about every type of industry and location, and under a very wide range of service extremes provide an experience record that thoroughly justifies their selection. Our booklet, "BAKELITE Resin Coatings for General Industry," shows numerous applications. For a free copy write Dept. YK-10.

BAKELITE
TRADE-MARK
Phenolic, Vinyl, Styrene RESINS FOR COATINGS

TRADE MARK

BAKELITE COMPANY
A Division of
Union Carbide and Carbon Corporation
UCC
30 East 42nd Street, New York 17, N. Y.

SLIDE ILLUMINATOR CASE molded of BAKELITE Phenolic Plastic is tough, strong, colorful. These easily molded materials reproduce finest molded details and give hard, glossy surface . . . color has attractive mottled effect. Made by J & M Products Co., Brooklyn, N. Y.

FORM-FITTING back brace is easily shaped under infra-red lamps in a few minutes, giving a custom fit. Made of BAKELITE Rigid Vinyl Sheet, it's cool, strong, washable, light in weight, less conspicious. Made by S. H. Camp & Co., Jackson, Michigan.

TOBACCO STAYS FRESH in this foil package with inner laminated lining of film made from BAKELITE Polyethylene. Film permits heat sealing, excludes air, strengthens foil. Made by Continental Can Co., Shellmar-Betner Flexible Packaging Div., Mount Vernon, Ohio.

Veeder-Root Hand Tally counts anything you see. Press thumb lever once for each count. Reset to zero with one turn of knob. $8.30 ea. (Write for quantity prices.) Immediate delivery.

If this Clicks often enough... then the show clicks, too!

Added Evidence that—

Everyone Can Count on

VEEDER-ROOT

275 laughs in 113 minutes . . . this was the certified count taken at a recent performance of a Broadway show by two executives of Fact Finders Associates, Inc. . . . both using Veeder-Root Hand Tallies.

This is another one of the hundreds of uses for each of the hundreds of Veeder-Root Counters which are made for manual, mechanical and electrical operation. Chances are that *you*, too, can count on Veeder-Root . . . with counters built into your products as standard parts, or attached to your production equipment. We'll help you to figure out how. Write:

VEEDER-ROOT INCORPORATED
HARTFORD 2, CONNECTICUT

Chicago 6, Ill. • New York 19, N. Y. • Greenville, S. C.
Montreal 2, Canada • Dundee, Scotland
Offices and Agents in Principal Cities

"The Name That Counts"

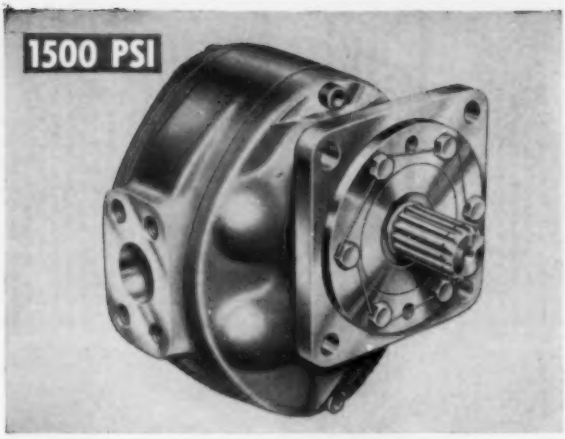
FOUR...

COMPLETELY NEW LINES OF HYDRAULIC PUMPS WHICH GIVE YOU FAR MORE IN PERFORMANCE AT FAR LESS IN COST!

- Pumps to give new life to existing equipment . . . to improve performance, increase capacity!
- Pumps that afford the design engineer the basic equipment for entirely new concepts in hydraulically operated machines!
- Pumps for machines to do work better, quicker, cheaper!

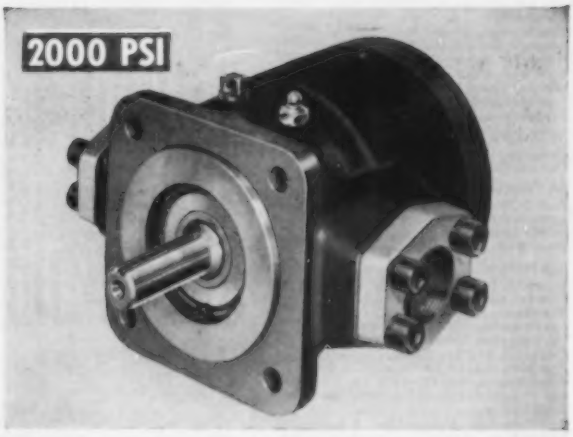
THE NEW YORK AIR BRAKE COMPANY

1112 EAST 222nd STREET • CLEVELAND 17 • OHIO



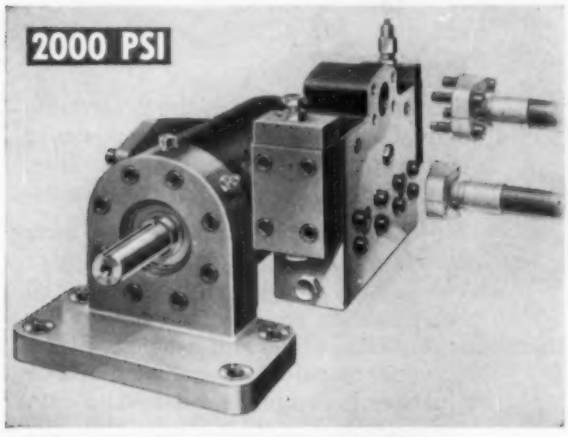
SERIES H GEAR-TYPE PUMPS

The HYDRECO Series H Pumps are intended for use in the hydraulic systems of heavy-duty mobile and industrial equipment, especially where shock loads, impact and rugged service are "normal working conditions". Four sizes (40, 50, 60, 70 gpm) deliver fluid power at 1500 psi . . . increased horsepower gives greater work output. *Pressure-Balanced* wear plates reduce oil slippage and eliminate power-robbing frictional contacts. SAE Flange Mounting and split-flange hose connections make servicing simple and reduce down-time. Equipment is on-the-job longer.



SERIES PF-100 VANE-TYPE PUMPS

DUDCO PF-100 Series Pumps can double the value of your *hydraulic dollar*. You get 2000 psi continuous duty, single-stage construction for the cost of equal capacity low pressure pumps . . . improved equipment design and increased machine efficiency without the payment of premium prices. These Pumps feature a simplified, 3-unit construction . . . the pumping cartridge incorporates the famous DUAL-VANE design which provides and assures complete balance of all hydraulic pressure loads. These Pumps have capacities of 3, 5, 8 and 11 gpm at 1200 rpm.



SERIES PF-100 DOUBLE PUMPS WITH VALVE PANELS

DUDCO PF-100 Series Double Pumps with Valve Panels are versatile units unmatched as a source of *Controlled Fluid Power* for a wide variety of modern industrial equipment . . . for 2000 psi operation of circuits calling for a substantial variation in pump volume as during "close and hold" or "traverse and feed" cycles. The Valve Panel contains the valving necessary for pressure regulation and flow control . . . the external part of a system will have less valves and controls, reduced piping and fewer parts to maintain. Ten capacity combinations with either automatic or remotely controlled operation.

SERIES PV-600 PISTON-TYPE PUMPS

DUDCO PV-600 Series Variable Delivery Pumps generate continuous duty pressures up to 5000 psi. Two types of controls match pump output to system demands. A pressure-compensated regulator automatically varies the volume in response to system pressure. A hand wheel control enables an operator to vary the volume during the machine cycle. High pressure variable delivery means power is transmitted without the necessity for an accumulator and without any wastage of power thru a relief valve.

WRITE TODAY . . .

Get full particulars on these important new developments in hydraulic pumps!

The New York Air Brake Company
1112 East 222nd Street
Cleveland 17, Ohio

Please send details on

- ☐ SERIES PF-100 VANE-TYPE PUMPS
- ☐ SERIES H GEAR-TYPE PUMPS
- ☐ SERIES PF-100 DOUBLE PUMPS WITH VALVE PANELS
- ☐ SERIES PV-600 PISTON-TYPE PUMPS

Name_____

Address_____

City_____ Zone____ State_____

ALABAMA
Birmingham, Electric Motor Service
Decatur, Decatur Electric Service Co.
Florence, Fortney Electric Company
Gadsden, Hood Electric Company
Mobile, Russell Electric Company
Montgomery, Standard Electric Co.
Tuscaloosa, Freeman's Electric Co.

ARIZONA
Phoenix, Vinson-Carter Electric Company
Tucson, Pima Electric Company

ARKANSAS
Fort Smith, Interstate Electric Company
Jonesboro, Turner Armature & Electric Works
North Little Rock, Brown Electric Co.
Pine Bluff, Jefferson Electric Company

CALIFORNIA
El Cajon, Tri-Electricians
Fresno, Valley Electric Motor Service
Glendale, Johnson Electric Company
Los Angeles, Hill Electric Company, Inc.
Los Angeles, Smallcomb Electric
Oakland, East Bay Electric Company
Pomona, Pomona Electric Machinery Co.
Sacramento, Van Alstyne & Son
San Diego, California Electric Works
San Jose, Kurze Electric Works
San Francisco, Standard Elec. & Engineering Co.
Santa Cruz, Waidelich Motors & Appliance
Santa Rosa, Leete Electric Motor Co.

COLORADO
Denver, Weaver Electric Company

CONNECTICUT
Hartford, Hartford Electric Machine Co.
New Haven, Schulz & Ingram, Inc.
Stamford, Palmer's Electric Motor Repair
Waterville, Traver Electric Motor Company

DELAWARE
Wilmington, McHugh Electric Company

DISTRICT OF COLUMBIA
Washington, Carty Elec. & Armature Service, Inc.

FLORIDA
Bradenton, Grubb's Electric Motor Repair
Jacksonville, Hudson Electric Motor Service
Miami, Florida Electric Motor Co.
Miami, Peninsula Armature Works
Orlando, Orlando Armature Works, Inc.
St. Petersburg, Van Domlen's Electric Motor & Armature Works
Tampa, Tampa Armature Works, Inc.

GEORGIA
Atlanta, A.A.A. Electric Motor Service
Columbus, Smith-Gray Electric Co.
Macon, Wilson Electric Company
Savannah, Electrical Machinery Company

IDAHO
Boise, Missman Electric Company
Idaho Falls, Rossiter Electric Sales and Service

ILLINOIS
Canton, Kroell Electric Co.
Chicago, Dahl Electric Company
Chicago, Excel Electric Service Co., Inc.
Chicago, Complete Electric Motor Repair Co.
Chicago, Inland Industrial Electric Service
Chicago, Palm Electric Motor Repair & Sales
East St. Louis, Bradford Electric Co.
Evanston, Rainbow Electric Company
Freeport, Alfred Koym
Jacksonville, Welborn Electric Company
Mt. Vernon, Dowzer Electric Machine Works, Inc.
Peoria, Foremost Electric Company, Inc.
Peoria, Hendricks Electric Company
Rock Falls, Hill's Electric Company
Waukegan, Del's Electric
Winnetka, Braun Brothers Heating Supply Co.

INDIANA
Evansville, Evansville Electric & Mfg. Co.
Fort Wayne, Wayne Electric Company
Frankfort, Martin Electric Service
Gary, Fleig Electric Company
Hammond, Mills Electric Company
Huntington, Christman Motor Repair
Indianapolis, Scherer Electric Company
South Bend, Koontz Wagner Electric Co., Inc.
Terre Haute, Smith-Decker Co.

IOWA
Cedar Rapids, Electric Motors Company
Clinton, Clinton Electric Motors
Davenport, Industrial Engineering Equip. Co., Inc.
Des Moines, Iowa Service Company
Sioux City, Smith Electric and Supply Co.

KANSAS
Hutchinson, Reno Implement & Hardware Co.
Wichita, Mears Electric Co.

KENTUCKY
Louisville, Owen Gollar Electric Co., Inc.
Paducah, England Electric Service

LOUISIANA
Lake Charles, J. & J. Armature Works of La., Inc.
Monroe, Monroe Armature Works
New Orleans, Bill Dreis, Inc.
Shreveport, Tench Electric Motor Works

MAINE
Brewer, Leen's Electric Motor Service
Portland, Stanley J. Leen Co., Inc.

MARYLAND
Baltimore, R. E. Michel Co., Inc.
Baltimore, Lange Electric Company
Hagerstown, Hagerstown Equipment Co., Inc.

MASSACHUSETTS
Boston, Sandman Electric Co., Inc.
Cambridge, Empire Electrical Co.
Springfield, Superior Electric Co., Inc.
Springfield, Anchor Electric Service Co., Inc.
Worcester, Alfred L. Brown Associates, Inc.

MICHIGAN
Battle Creek, Commercial Electric Co.
Detroit, Werner Electric Co.
Detroit, J. C. Electric Motor Repairs
Flint, Dudley Electric Works
Grand Rapids, Motman Hondorp Corp.
Jackson, Cochran Electric Co.
Kalamazoo, Electric Construction & Mach. Co.
Lansing, Barker-Fowler Electric Co.
Muskegon, Jones Electric Company
Pontiac, Electric Motor Service
South Haven, Haines Electric Motor Service
Saginaw, Henry Electric Co.
Traverse City, Northwestern Electric Service, Inc.

MINNESOTA
Austin, Powerite Electric Motor Co.
Bemidji, Swenson Electric Company
Duluth, Mielke Electric Works, Inc.
Fairmont, Ross Electric Motor Shop
Fergus Falls, Knutson Electric
Mankato, Reliance Electric Company
Minneapolis, Boutwell Electric and Mfg. Co.
Minneapolis, Parsons Electric Co.
Moorhead, Horvick Electric Motor Co.
New Ulm, Ulrich Electric Co.
Rochester, Watkins Electric Motor Service
St. Cloud, Electric Motor Service

MISSISSIPPI
Jackson, Burkett's Electric Motor Service

MISSOURI
Kansas City, Independent Electric Machinery Co.
Springfield, Springfield Electric Service Company
St. Louis, Acme Electric Company

MONTANA
Beatrice, Sprague Electric Service, Inc.
Billings, Carburetor and Electric Company
Havre, The O. B. Lund Company
Missoula, City Electric Co.

NEBRASKA
Lincoln, Colin Electric Motor Service
Omaha, Omaha Electrical Works
Scottsbluff, H. M. Brown Electric Co.

NEW HAMPSHIRE
Concord, A. S. Tracy

NEW JERSEY
Atlantic City, Charles A. Buckley
Hawthorne, Industrial Electric Service Co.
Newark, Electric Motor Rebuilding Co.
No. Plainfield, The Hoover Co., Elec. Motor Div.
Trenton, Lockwood's Electric Motor Service

NEW MEXICO
Albuquerque, Electric Service, Inc.
Lancaster, Lancaster Electric Service Co.
New Philadelphia, Fenton Bros. Electric Co.
Piqua, Electric Motor Service
Springfield, B & M Electric Company
St. Marys, Mader Electric Motor Service
Toledo, The Fred W. Kienle Co.
Warren, Warren Armature Works
Youngstown, J. B. Winkle Co.

OKLAHOMA
Muskogee, Geheb Electric Company
Oklahoma City, Refrigeration Sales & Eng. Co.
Tulsa, Bartlett Electric Company

OREGON
Eugene, Keith Electric Motor Service
Portland, Walker Electric Works
Portland, Western Motor Service

PENNSYLVANIA
Allentown, Everson Electric Co.
Easton, Stokes Engineering & Supply Co.
Erie, A. G. Nungamaker Electric
Lancaster, J. C. Neuhauser and Son
Luzerne, Croball Electric Repair Service
Philadelphia, Penn Electric Motors Co.
Pittsburgh, Braunlich-Roesale Co.
Steelton, Electric Service & Machine Co., Inc.
Williamsport, G. I. Electric Co.
York, Industrial Electric Co.

RHODE ISLAND
Pawtucket, New England Machine & Electric Co.
Providence, Schmidt Electric Company

SOUTH CAROLINA
Columbia: Columbia Electric Repair Co., Inc.
Columbia: Electric Motor & Repair Company
Greenville, Southern Electric Service Co., Inc.
Spartanburg, Southern Electric Service Co., Inc.
Sumter, Sumter Electric Rewinding Co.

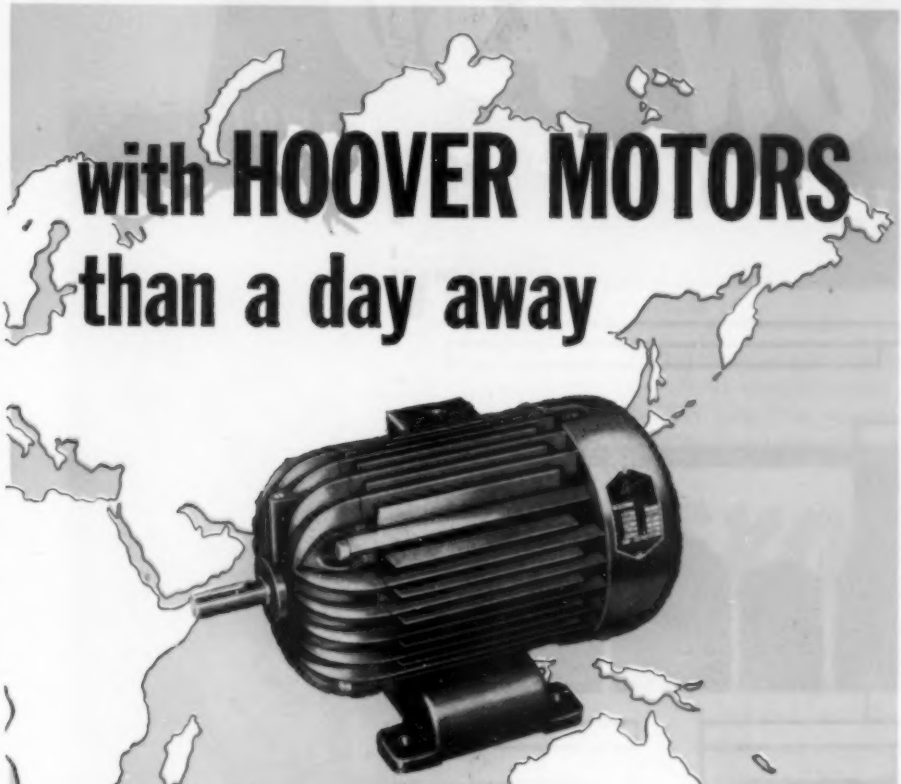
SOUTH DAKOTA
Sioux Falls, Electric Motor Repair
Sioux Falls, Shakstad Electric & Machine Works
Yankton, Cowman & Hicks

TENNESSEE
Chattanooga, Chattanooga Armature Works
Kingsport, Kingsport Armature Motor Works
Knoxville, Tennessee Armature & Electric Co.
Knoxville, Tennessee Electric Motor Service
Memphis, Southern Electric Co.
Nashville, Tennessee Electric Motor Service

TEXAS
Abilene, Brown's Electric Service
Amarillo, G. E. Jones Electric Co., Inc.
Brownsville, Imperial Electric Motor Service
Beaumont, J. & J. Armature Works, Inc.
Corpus Christi, Bradley's Motor & Arm. Works
Dallas, W. M. Smith Electric Co.
Ft. Worth, Foshee Electric Company
Galveston, Electric Supply Co.
Houston, American Armature Works
Odessa, Duke Electric Co.
San Angelo, Electric Service Co.
San Antonio, Loyd Electric Company
San Antonio. San Antonio Armature Works, Inc.

Wherever you power service is less
Most users say Hoover is the no-trouble motor—never any output for upkeep, never any stoppage on the production line, never any downtime in commercial equipment.
But if trouble ever does strike, your customer is mighty happy to know motor service is only hours away. He can call any nearby Hoover Service Agency (there are more than 300!) and get immediate, expert attention. Usually repairs or adjustments are made within the day.
Good will? You bet! It's also good business—for when you tell your prospects "It's powered (and serviced) by Hoover," it really helps you sell.

with HOOVER MOTORS than a day away



If you want to save money on fractional or integral horsepower electric motors, for industrial or commercial equipment, send this coupon now. Dozens of applications fitted from low-cost in-production models (up to 5 h.p.). Or Hoover engineers will work with your engineers to develop a model exactly right for you. Economically, too.

NEW YORK
Albany, Casey's Electrical Repair Shop
Binghamton, M. Gleason & Sons
Brooklyn, B & B Electric Co., Inc.
Buffalo, S-S Electric Repair Shop, Inc.
Jamaica, Queens Electric Motors
Jamestown, A. E. Westburgh
Kingston, P. J. Gallagher
L. I., Amityville Battery & Ignition Service
L. I., Milford Electric Motors
New York, Consolidated Electric Motor Company
Rochester, T. H. Green Electric Co., Inc.
Rochester, O. G. Schwarz Company
Schenectady, Gray Electric Co.
Schenectady, Barrett Electric Service, Inc.
Syracuse, Murray Electric
Utica, Mather Evans & Diehl Co., Inc.

NORTH CAROLINA
Asheville, Hayes & Lunsford Electric Company
Charlotte, Jones Electric Repair Company
Charlotte, Southern Electric Service Co., Inc.
Durham, Triangle Electric Motor Co., Inc.
Fayetteville, Electric Motor & Repair Company
Gastonia, Bryant Supply Co., Inc.
Greensboro, Southern Electric Service Co., Inc.
Raleigh, Electric Motor & Repair Company

NORTH DAKOTA
Grand Forks, Forks Electric Motor

OHIO
Akron, The A-C Supply Co.
Alliance, Alliance Electric Company
Ashland, Smith Electric Shop
Bellefontaine, Electric Motor & Supply Co.
Canton, Hannon Electric Co.
Cincinnati, Matlock Electric Co.
Cleveland, Independent Electric Motor Repair
Columbus, Columbus Electric Works
Dayton, The Dayton Electric Service Co.
Sherman, Duke Electric
Sweetwater, Sweetwater Electric Co.
Texarkana, Texarkana Armature Works
Waco, Caldwell Electric Shop
Wichita Falls, Savage-Phillips Electric Company

UTAH
Salt Lake City, Electric Motor & Supply

VERMONT
White River Jct., T. & L. Electric, Inc.

VIRGINIA
Richmond, Electric Motor & Repair Company

WASHINGTON
Seattle, Fellstrom Electric Company
Seattle, United Electric Motors Inc.
Spokane, K & N Electric Motors Inc.
Tacoma, Electric Motor Service Company

WEST VIRGINIA
Parkersburg, Electric Motor Service Co.

WISCONSIN
Green Bay, Electric Motor Service
Kenosha, Hammes Electric Motor Co.
Madison, Electric Motor Service
Manitowoc, Manitowoc Electric Motor Co.
Milwaukee, Holt Electric Motor Co.
Milwaukee, Quality Electric Service
Whitewater, Mulks Electric Motor Service

INTERNATIONAL

AUSTRALIA
Sidney, New South Wales, Hoover (Australia) Pty. Ltd.

ARGENTINA
Buenos Aires, Gonzales, Castleton & Shaw

BELGIUM
Brussels, L'Etablissements Hoover S.A.

BERMUDA
Hamilton, Butterfield & Co., Ltd

BRAZIL
Rio de Janeiro, Philips do Brazil

BRITISH EAST AFRICA
Nairobi, Kenya, The Car & Gen. Equip. Co., Ltd

CANADA
ALBERTA
Calgary, Davies Electric Co.
Edmonton, Electric Motor Sales, Ltd.
BRITISH COLUMBIA
Vancouver, The Hoover Company Ltd.
Victoria, Ascroft Electrical Machinery Co., Ltd.
MANITOBA
Winnipeg, The Hoover Company Ltd.
NEW BRUNSWICK
Saint John, E. S. Stephenson & Co., Ltd.
NEWFOUNDLAND
Saint John's, Gt. Eastern Oil & Import Co., Ltd.
NOVA SCOTIA
Halifax, Nova Scotia Armature Works
ONTARIO
Chatham, Chandler Electric Co.
Fort William, Mahon Electric
Hamilton, The Hoover Company, Ltd.
London, Johnson-Turner Elect. Repair & Eng. Co.
Ottawa, The Hoover Company, Ltd.
Sarnia, Johnson-Turner Elec. Repair & Eng. Co.
Windsor, Johnson-Turner Elec. Repair & Eng. Co.
PRINCE EDWARD ISLAND
Charlottetown, Palmer Electric Co.
QUEBEC
Chicoutimi, Hudson Electrical Works Reg'd.
Montreal, The Hoover Company, Ltd.
SASKATCHEWAN
Regina, Electric Motor Service
Saskatoon, Davies Electric Co.

CUBA
Habana, W. M. Anderson Trading Co., S. A.

DENMARK
Copenhagen, I. G. S. Electric

EGYPT
Alexandria, R. Roditi & Co.

FINLAND
Helsinki, Havulinna Oy

FRANCE
Paris VIII, Etablissements Hoover S. A.

GREAT BRITAIN
BIRMINGHAM
Warwicks, Grove Works
BRISTOL
Gloucestershire, Hoover Limited
DUBLIN
Eire, Hoover Limited
GLASGOW
Glasgow, S.W. 2, Hoover Limited
LEEDS
Leeds, Hoover Limited
LONDON
London, N. W. 10, Hoover Limited
MANCHESTER
Manchester 13, Empire Yard, Daisy Works

GREECE
Athens, B & C Panayotidis

HOLLAND
Amsterdam, N. V. De Hoover Handelmaatschappij

IRAN
Teheran, Grigori Mirzatuny

LEBANON & SYRIA
Beirut, Henry Heald & Co.

MEXICO
Mexico City, Electronics, S.A.

NEW ZEALAND
Auckland, F. W. Cave Ltd.

NORWAY
Oslo, Olav Le Maire Amundsen

PAKISTAN
Karachi, Electronics & Film Equipments Ltd.

PARAGUAY
Asuncion, Juan Penoni & Co.

PORTUGAL
Lisbon, Leacock (Lisboa) Lda.

SOUTH AFRICA
Johannesburg, Hoover S. A. Pty. Ltd.

SUDAN
Khartoum, Gellatly, Hankey & Co. (Sudan) Ltd.

SWEDEN
Stockholm 6, A-B Elektroholm

SWITZERLAND
Zurich, Hoover-Apparate A. G.

TANGIER, Tangier, Mr. Maurice Arditti

TURKEY, Istanbul, The Matos Trading Corp.

URUGUAY, Montevideo, Districom S.R.L.

THE HOOVER COMPANY, ELECTRIC MOTOR DIVISION
92 Brook Avenue, North Plainfield, N. J.

☐ Please send latest bulletins on Hoover Service System.

☐ Please send further information on Hoover Motors. I am particularly interested in motors for _____ (indicate type of equipment)

Name _____

Company _____

Address _____

City _____ Zone _____ State _____

PRODUCTION FOR HOME AND DEFENSE

Week in and week out, Hoover is producing a very substantial volume of essential materials for the Armed Forces.

now you can

GIVE YOUR SALES FORCE

Superior Products of Varied Sizes and Shapes Can Be Vacuum Formed from Rigid Vinyl Sheets Made from EXON 450!

In end products as shown above, get excellent dimensional stability, needle sharp clarity of minute details. These exceptional characteristics are due to the unusual properties of the base resin used–EXON 450.

THE FINEST COMPETITIVE RIGID VINYL SHEET

The finest rigid vinyl sheets can now be processed with unusual economy. *One* resin—EXON 450—instead of *two*, can be formulated to meet ASTM D708 44T (Grade 1).

Fabricators of vacuum formed products have reported excellent results using rigid sheets processed from EXON 450. This superior resin is endowed with many outstanding properties. For example—

EXON 450

- maintains excellent color and clarity
- may be easily formed
- has excellent electrical properties
- does not support combustion
- takes a high surface finish
- has fine dimensional stability

More and more, industry looks to Firestone for specific resins for specific needs. EXON 450 is one example. Whatever *your* problem, look for the answer in the ever-expanding line of versatile Firestone EXON resins.

For complete information or consultation on any processing problem... call or write

CHEMICAL SALES DIVISION

Firestone Plastics Co., Dept. 6E, Pottstown, Pa.
Division of the Firestone Tire & Rubber Co.

J&H Motors on 24-hour duty in

HERE WAS THE NEED

Given Manufacturing Company of Los Angeles needed a rugged, specially built motor to power its famous WASTE KING Commercial *Pulverator* . . . a heavy-duty garbage disposer designed for commercial and institutional use. Installed in a kitchen's critical food-waste "point-of-origin", the unit had to have a motor that would operate on a 24-hour basis under variable peak loads, high heat and moisture.

Customized JACK & HEINTZ

Waste King PULVERATOR

Commercial Pulverators

Manufacturer reports unsurpassed service record!

In custom-designing a motor for Given Manufacturing Company's WASTE KING Commercial *Pulverator*, Jack & Heintz engineers developed a rugged, specially built motor that more than answers the customer's requirements of dependability and long life.

In spite of the fact that the commercial garbage disposer unit operates on virtually 24-hour continuous duty, under variable loads and conditions of high heat and moisture, the manufacturer reports that the service record of his units is remarkable—unsurpassed in the industry.

These 5 J&H *Customized* Motor features help WASTE KING set new records for dependability

1 Special frame and motor fan provide maximum ventilation; dissipate heat created by severe load and environmental conditions.

2 Stators double-dipped in special insulating varnish. Prolongs life of unit under conditions of high humidity.

3 Motor engineered for extremely high breakdown torque. Essential to compensate for variable shock loads during peak periods of service.

4 Rotor shaft specially machined to fit cutting turntable of disposer.

5 Dynamic balancing to close tolerance assures smooth performance—makes WASTE KING Commercial *Pulverator* a machine of high precision.

Here is the Result—

a rugged J&H *Customized* Motor incorporating electrical and mechanical features designed to make it an integral part of the WASTE KING Commercial *Pulverator*.

OVER 350,000 J&H Motors power Household WASTE KING Pulverators *every day!*

DESIGN YOUR PRODUCT TO DO A JOB...

not to fit a motor

Avoid compromising your product design by taking advantage of an engineering philosophy geared to solve your special motor needs. *Design your product to do a job . . . not to fit a motor.* Write Jack & Heintz, Inc., 17627 Broadway, Cleveland 1, Ohio.

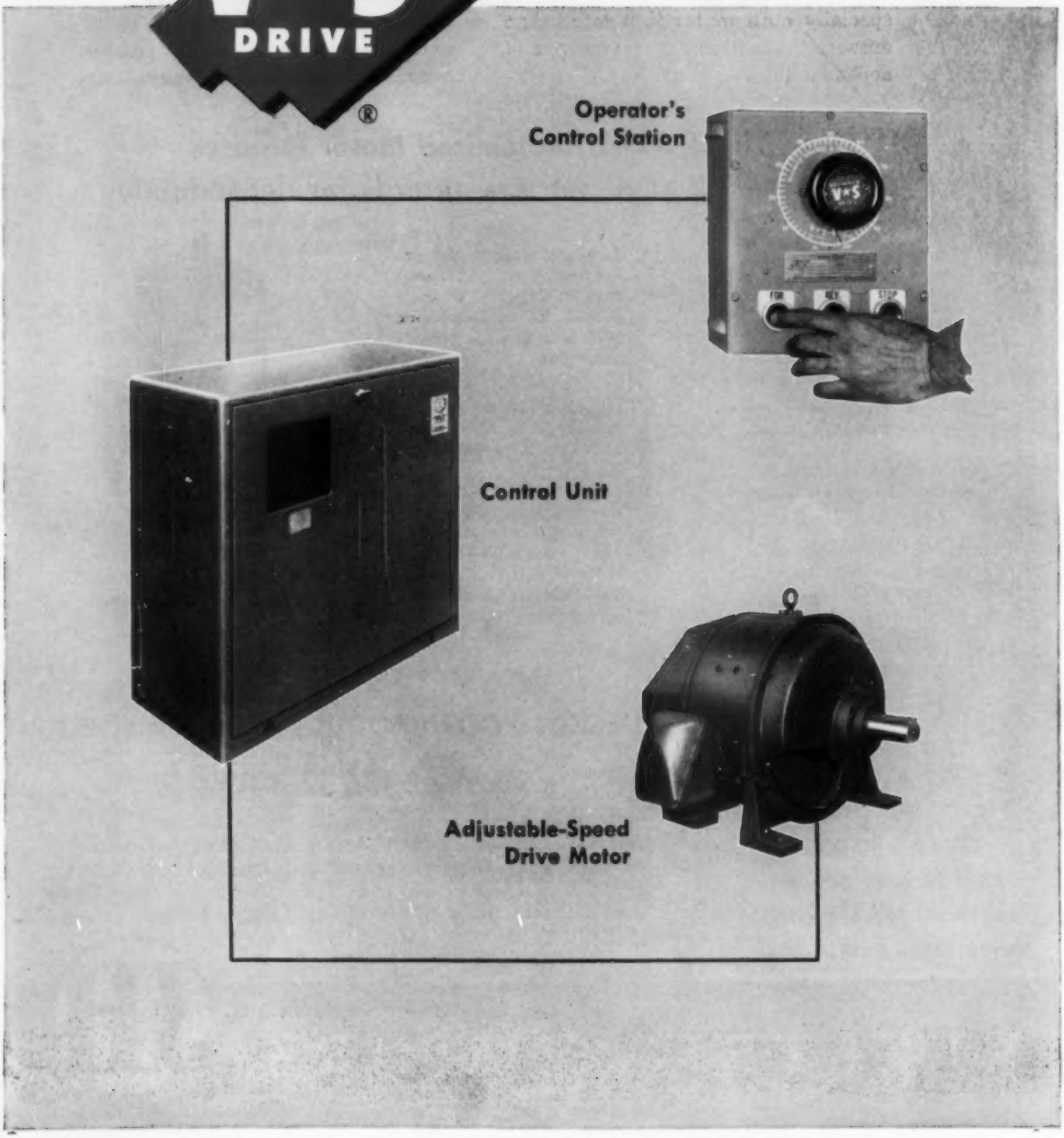
ELECTRIC MOTORS

J&H

BUILT AND APPLIED BY RELIANCE

THESE *Tools of Automation* INCREASE

RELIANCE V★S DRIVE ®



PRODUCTION OUTPUT IN EVERY INDUSTRY

moving things faster...more accurately!

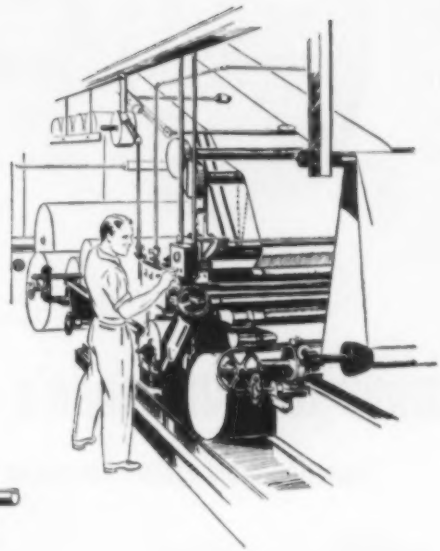
RELIANCE *Precision-Built* MOTORS

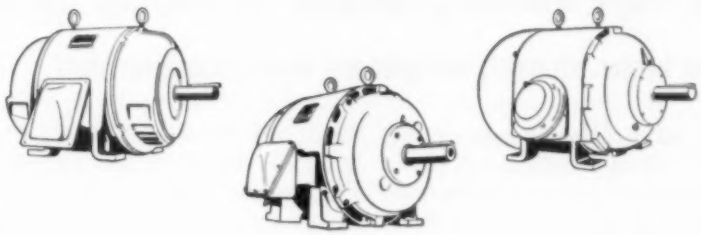
Reliance electric motors, adjustable-speed drives, electronic controls, and applied engineering—the Tools of Automation—make it possible to secure increased production in a single machine . . . part of a process . . . or an entire factory.

And these tools provide all the dependability and economy you need to get complete benefits of automated equipment. They have established an unequaled record of performance under the most exacting operating conditions in industries like paper, textile, chemical, steel, metal working and automotive.

One of the most important Tools of Automation is Reliance Applied Engineering which is used to analyze and supply the answer to your specific situation. Reliance engineering is backed by nearly 50 years of experience in the development and engineering of drive systems which have made automation possible.

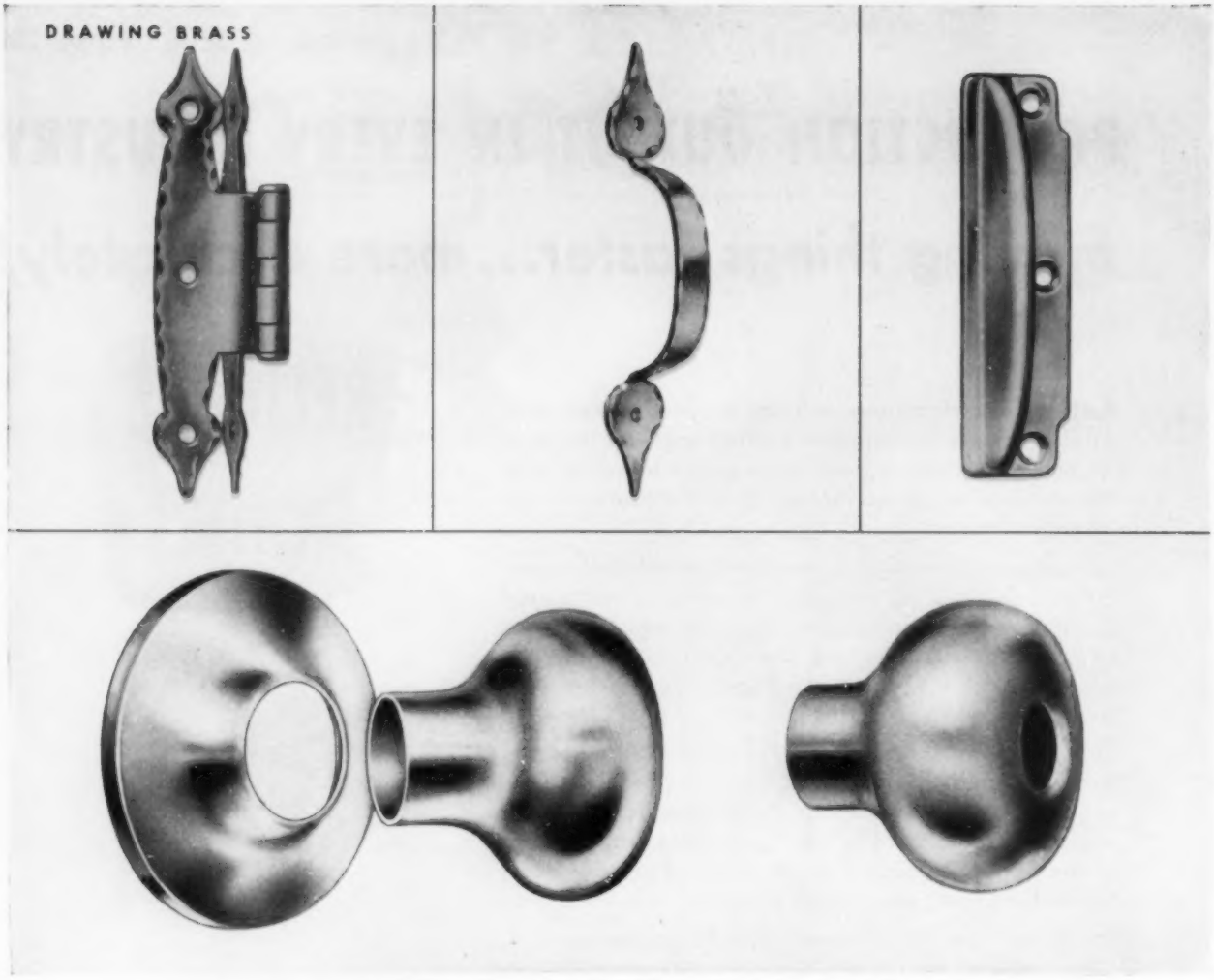
For all the facts, write for your copy of our new booklet, "The Tools of Automation". A-1474-A





RELIANCE ELECTRIC AND ENGINEERING CO.

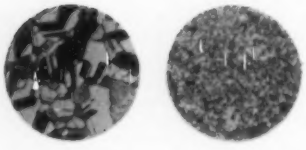
1080 Ivanhoe Road, Cleveland 10, Ohio • *Sales Representatives in Principal Cities*



THESE HARDWARE ITEMS are made by Adams Rite Mfg. Co., Glendale, Cal., and National Lock Co. and American Cabinet Hardware Co., both of Rockford, Ill. They are typical of the stamped, drawn and pressed products

Formbrite—Anaconda's new drawing brass—polishes up to

Superfine grain makes Formbrite harder, stronger, springier and more scratch-resistant



75X magnification of ordinary drawing brass. 75X magnification of superfine-grain Formbrite.

Here is what enthusiastic manufacturers of stamped and drawn brass products say about *Formbrite:*

". . . cuts our polishing costs up to 50% . . . eliminates some finishing operations entirely . . . gives amazingly sharp die impressions...resists scratching in handling . . . plates beautifully . . . gives a more lustrous finish . . ."

Yet *Formbrite** costs no more than the ordinary drawing brasses these manufacturers had been using. In fact, Formbrite very often saves more than the metal itself costs.

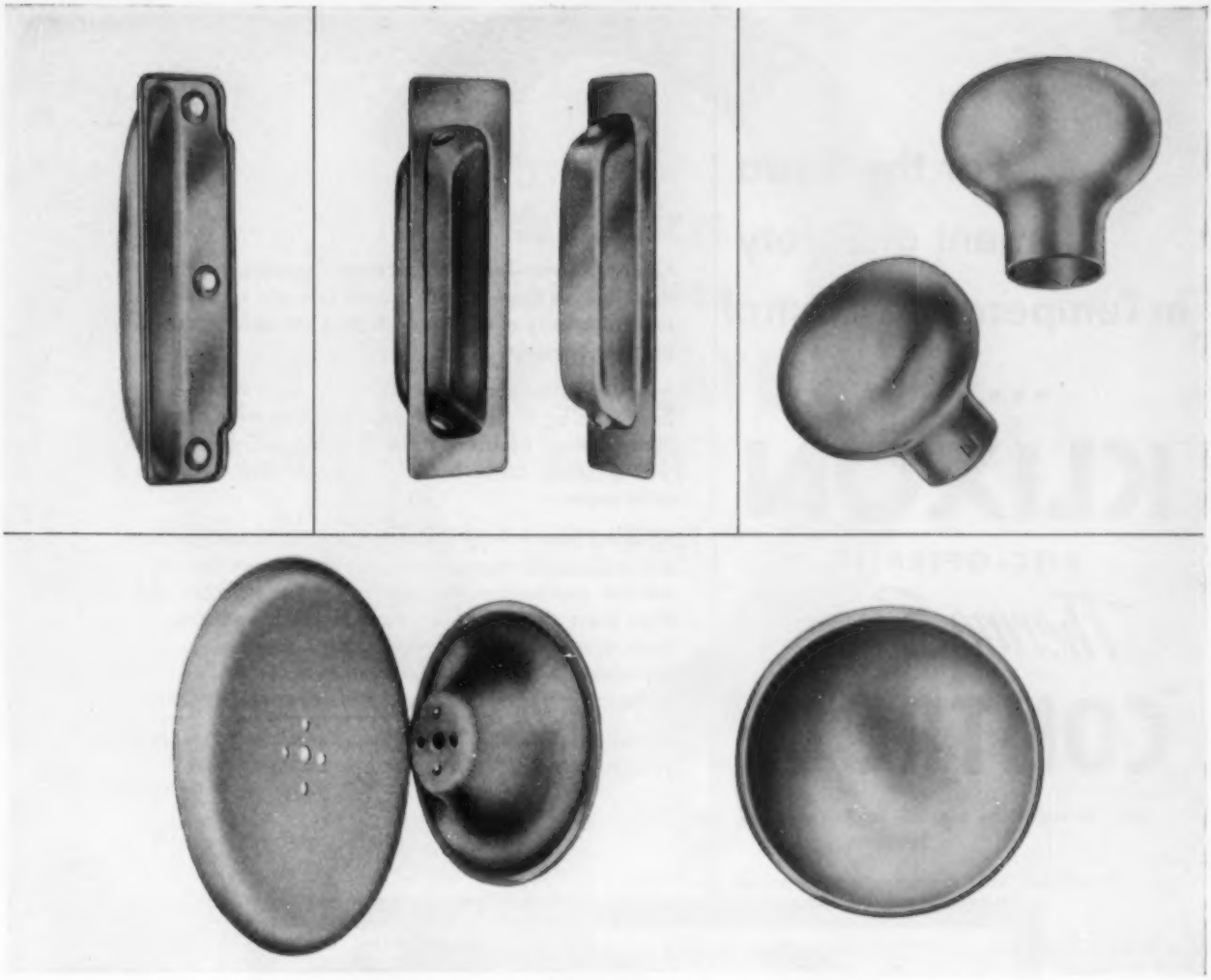
Why Formbrite is easier to use

Note Formbrite's superfine grain structure. Compare it with that of ordinary drawing brass. Special methods of rolling and annealing produce a grain structure so fine that often a simple color buff will bring it to a bright, lustrous finish.

Formbrite is also harder, stiffer, springier and more scratch-resistant . . . yet it is surprisingly ductile, readily stamped, formed, drawn and embossed.

Typical case

The Adams Rite Mfg. Co. makes the flush pull shown in the upper right



successfully made of Formbrite. Others include: lipstick holders, fishing lures, automobile hubcaps, gage cases, trophy nameplates, pen caps, etc. (Doorknob parts in lower left illustration have been chromium plated.)

50% faster...costs no more than ordinary drawing brass

illustration above. For this and many other building hardware items, they use Formbrite. They report:

"Formbrite increases surface hardness and rigidity of the part . . .eliminates several polishing operations and reduces over-all costs. Our flush pull definitely has been improved in quality."

Free sample

Formbrite is available in sheet, strip and coils—in all commercial widths and gages. Millions of pounds of this superior drawing brass have been made, sold and satisfactorily fabricated.

Want more proof? Mail the coupon and we'll send you a sample of Formbrite. Try it in your polishing room. See for yourself how quickly and easily Formbrite polishes. 5488

*Reg. U. S. Pat. Off.

Formbrite

FINE-GRAIN DRAWING BRASS

AN ANACONDA* PRODUCT

MADE BY THE AMERICAN BRASS COMPANY

FREE SAMPLE—Test Formbrite Yourself

The American Brass Company, Waterbury 20, Connecticut

(In Canada: Anaconda American Brass Ltd., New Toronto, Ont.)

☐ Send me a free sample of Formbrite to try in my polishing room.

☐ Send me Publication B-39, giving forming and finishing suggestions.

NAME.....

COMPANY.....

STREET.....

CITY.....ZONE.....STATE.....

For the Extra Element of Safety in Temperature Control ...USE

KLIXON

DISC-OPERATED

Thermo Snap®

CONTROLS

Klixon *Thermo-Snap* Temperature Controls, specially designed for built-in application, give you accurate control usually at a lower cost than expensive general purpose controls.

Actuated by the simple Spencer Disc, these controls have nothing to get out of adjustment or wear out. The "snap-action" of this Spencer Disc "opens" the circuit with a quick, clean break . . . "closes" the circuit to a solid make.

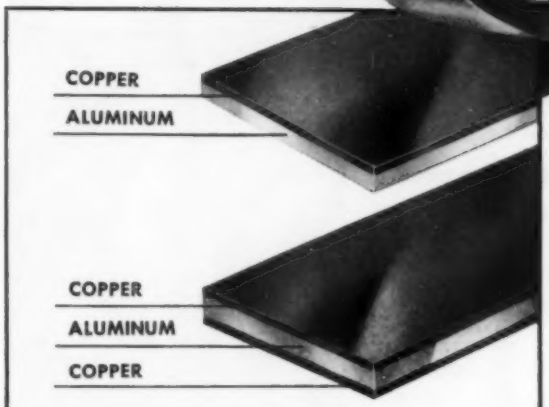
Klixon Thermo-Snap Controls are used, in both civilian and military products, in such applications as electric heaters, gas heaters, oil heaters for fan switches and high limit shut-offs . . . in aircraft, truck and bus heaters, soldering guns, melting pots, ironing machines, flat irons for temperature control . . . in radio equipment for tube and rectifier cooling control.

Investigate Klixon Thermo-Snap Controls for use in your equipment. Write for complete information.

KLIXON

TRADE MARK REG. U. S. PAT. OFF.

METALS & CONTROLS CORPORATION
SPENCER THERMOSTAT DIVISION
909 FOREST ST., ATTLEBORO, MASS.



ALCUPLATE FEATURES

- Natural copper appearance
- High electrical conductivity
- Excellent heat dissipation
- Soft-soldering surfaces
- Easy fabrication
- Light weight

Q *How can you reduce the cost of copper or brass in your parts or products?*

A *Get the same copper surface area and natural thickness with less copper.*

And that is *exactly* what ALCUPLATE does. ALCUPLATE is a solid layer of copper permanently clad — to one side or both sides of less expensive aluminum.

THUS ON ONE SIDE

OR THUS ON BOTH SIDES

THIS gives you solid copper performance at a 15 to 30% lower cost over solid copper.

Yet, in addition to this cost reduction, ALCUPLATE provides virtually the same physical and electrical properties as solid copper.

FABRICATING PROPERTIES

ALCUPLATE can be fabricated by stamping, drawing, spinning and forming. The copper provides an ideal surface for soft-soldering operations, electroplating or other finishes.

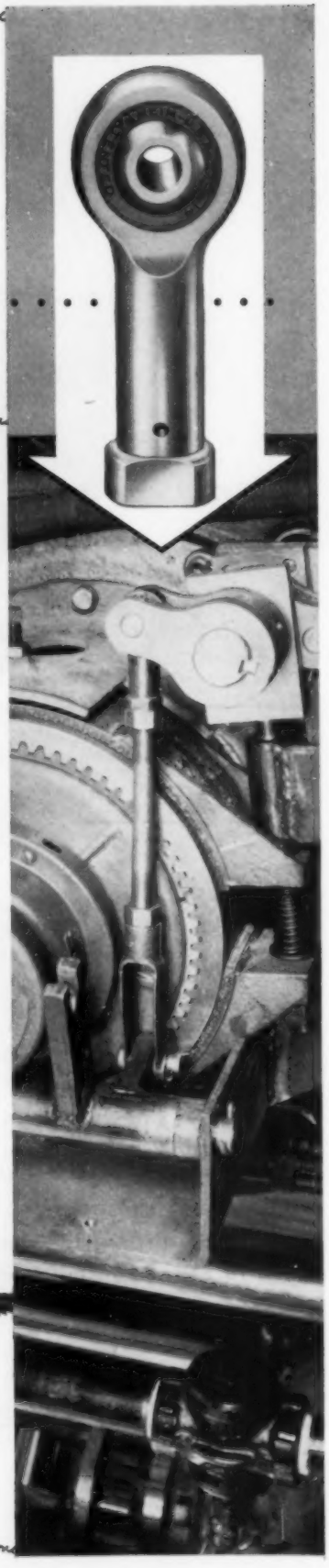
SIZES AVAILABLE

ALCUPLATE is available in coils or flat stock up to 1/16" thick x 13" wide and in a choice of thickness ratios and tempers.

For further information, write or wire

ALCUPLATE®
METALS & CONTROLS CORPORATION
GENERAL PLATE DIVISION
19 FOREST ST., ATTLEBORO, MASS.

Compressed Air Clutch
operated by .....
HEIM *Unibal* ROD END .....

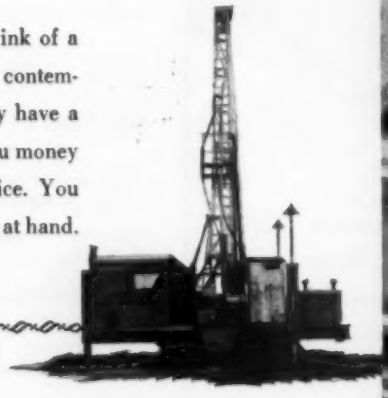


On the Joy Champion Blast Hole Drill, there is a compressed air operated clutch which is used for tramming a machine with special wide crawler treads used on the soft ground in strip mines operations. A heavy duty, self-aligning HEIM Rod End transmits the motion through the linkage operating this clutch.

Why Use HEIM?

When power or motion must be transmitted at odd or varying angles, some form of universal joint must be used. Heim Rod Ends, with their single Unibal principle, reduce friction, correct misalignment, carry maximum radial and thrust loads, and cost less than specially made connections.

Whether your product perches on the brink of a strip mine or is one of the thousands of contemporary tools and machines, you probably have a place where a Heim Rod End can save you money or deliver smoother, longer-lasting service. You should at least have the new Heim catalog at hand.



THE HEIM COMPANY
FAIRFIELD, CONNECTICUT

An important message concerning a new –and unique– alloy steel

UNITED STATES STEEL is pleased to announce to all steel consumers a new steel which we feel sure will enable you to improve the performance, lengthen the life, and reduce the cost of industrial equipment. This new engineering material is USS Carilloy T-1 steel, which recently underwent some very severe testing in Birmingham, Alabama.

The development of T-1 steel began back in 1947, when our research people took a good look at a problem that had plagued alloy plate steel users for years. That problem was the multiplicity of compositions required to do everyday jobs. There was no one composition available that could serve a wide variety of applications—so our research people set out to develop such a steel. The steel we wanted had to possess many unusual attributes such as very high strength, unusual toughness, good weldability and excellent resistance to impact abrasion at temperatures from minus 150°F. up to as high as 900°F.

Today such a steel is a reality. It is USS Carilloy T-1 steel, which has been tested thoroughly, both in the laboratory and in actual service applications. To prove further the capabilities of this new Carilloy steel, Chicago Bridge & Iron Company and United States Steel this summer carried out a joint testing program on commercial pressure vessels built from T-1 steel. The results of these tests and their significance to all steel users are described on the next three pages. We feel sure that you will find the story well worth reading.

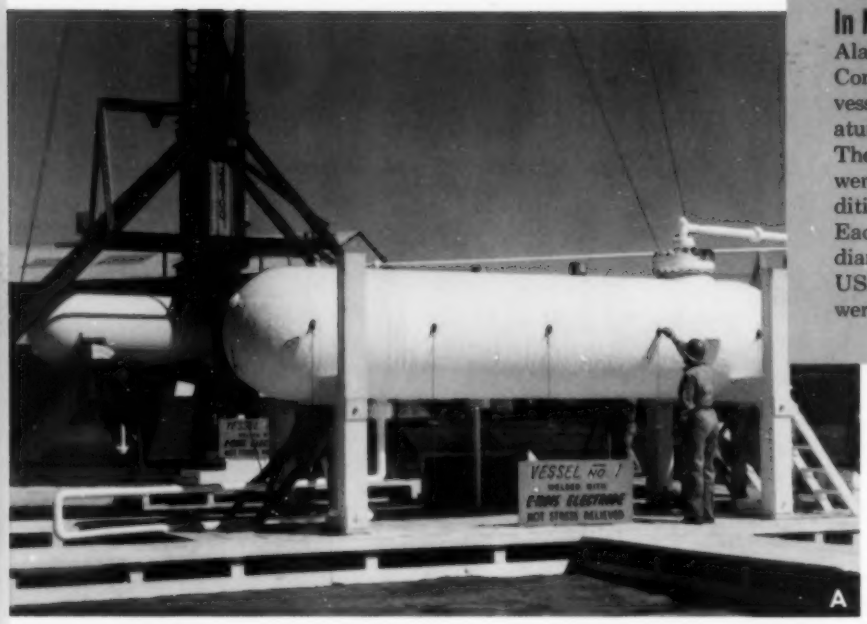
USS TRADE MARK

UNITED STATES STEEL

Remarkable new engineering material

PROVES SUPER-TOUGH

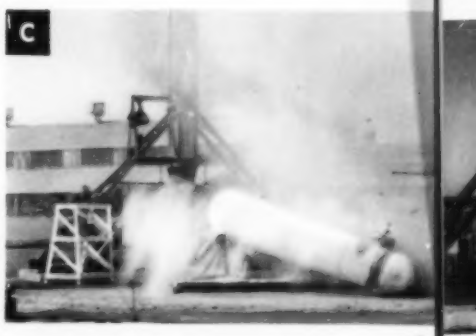
In May and June, 1954, at the Birmingham, Alabama, plant of Chicago Bridge & Iron Company, eight welded cylindrical pressure vessels were refrigerated to subzero temperatures and deliberately tested to destruction. The vessels were all standard designs that were built under normal production-line conditions by Chicago Bridge & Iron Company. Each vessel was twenty feet long, four feet in diameter, and made of half-inch plates of USS Carilloy T-1 steel. Four of the vessels were welded without stress relieving, using



A

B

C



In pressure test at 38°F. below zero T-1 steel withstands stresses 3 times its design strength

This vessel, not stress relieved, was refrigerated to −45°F. Then, with a quarter inch of white frost clinging to its sides, a high pressure pump slowly chugged the pressure in the vessel up to 938 psi. At that point, the steel itself was stressed to 45,000 psi., which is one half the yield strength of T-1 steel.

The hydraulic pressure was forced still higher, to 1875 psi. At this pressure, the stress in the steel had reached 90,000 psi.—the full *nominal* yield strength. Still, every inch of the metal was sound and all welds were intact.

Now the test really came. The pump labored on, and the pressure climbed to 2,000 psi. . . . to 2500 . . . to 2850 psi. . . . then . . .

BOOM! A jet of yellow brine burst out of the vessel and shot 200 feet through the air. The vessel finally failed at a pressure of 2850 psi. and a minimum stress of 136,000 psi. on the plates. This stress is well over three times the design strength of 45,000 psi.

The temperature of the steel at the time of failure was a frigid 38 below, yet the metal showed no sign of brittle failure. Super-tough USS Carilloy T-1 did what no ordinary steel could do at such a low temperature—it stayed *tough and ductile;* in fact it actually stopped the tear from propagating any further through the vessel.

USS

UNITED STATES STEEL

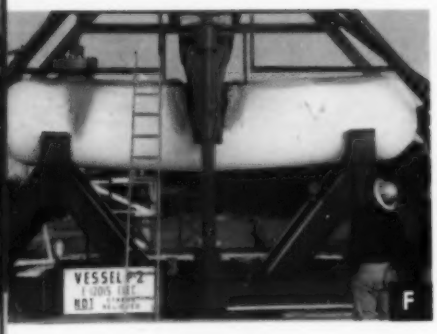
USS CARILLOY T-1 STEEL

DOWN TO 38°F. BELOW ZERO

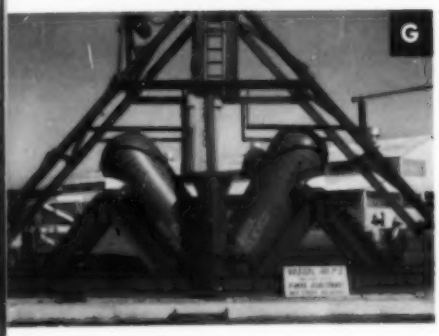
E 12015 low hydrogen coated electrodes. The other four were welded with E 9015 electrodes and were stress relieved after welding. Two vessels of each type were given two tests: a pressure burst test for strength and ductility, and an impact punishment test for toughness and resistance to the most severe impact conditions that could be devised.

Results of these tests, described below, prove conclusively the exceptional strength and toughness of USS Carilloy T-1 steel, even at temperatures far below freezing.

E



F


G

H

Frozen steel vessel made of Carilloy T-1 survives blow from 13-ton ingot dropped 73 ft.

A steel ingot weighing 26,700 lbs. has just plummeted 52 feet and crunched on top of this test vessel (Fig. E). The ingot was traveling 39 miles per hour when it hit. It struck with an impact energy of about 1,400,000 ft. lbs., bounced fifteen feet, and crushed down again on top of the vessel.

This vessel was welded without stress relieving. It was refrigerated to 33°F. below zero. It was pressurized to 1,875 psi. equal to a stress on the plates of 90,000 psi.—the steel's *nominal* yield strength. Yet, it did not fail. The ingot left only a 7/16 inch dent in the top, with a slight bulge on either side of the dent.

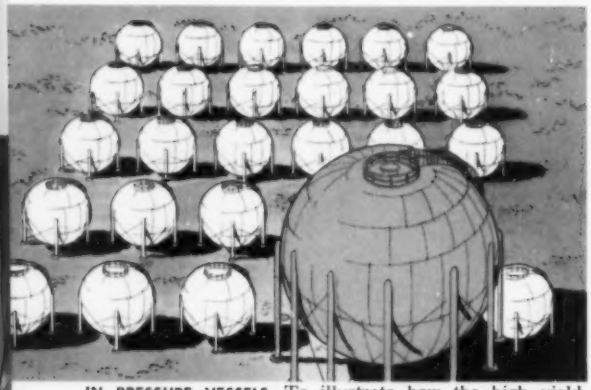
The test was repeated (Fig. F). This time the ingot was raised 73 feet, then dropped. It pounded down again on the very same spot on top of the vessel. Traveling at 46.7 miles per hour, it hit with an impact blow of 1,960,000 ft. lbs. The dent merely deepened – the steel and all welds were still intact.

Again the test was repeated (Fig. G). Now dropped from 101 feet, the 13-ton ingot ploughed into the top of the vessel at a speed of 55 miles per hour, hit with an impact of 2,750,000 ft. lbs. This time the vessel failed. But it didn't shatter. It didn't crack. It tore open like a tough piece of hickory. In other words, it failed without any signs of brittleness, even though the temperature of the steel was now minus 22°F.

In addition to this tremendous resistance to impact abuse, combined with remarkable sub-zero toughness, Carilloy T-1 steel also gives you excellent resistance to impact abrasion . . . good high temperature strength . . . and exceptional weldability.

Turn the page to see how you can use this remarkable new steel to cut costs and improve performance in a great variety of products.

Here's where you can reduce costs with USS Carilloy T-1 steel



IN PRESSURE VESSELS. To illustrate how the high yield strength of Carilloy T-1 steel can pay off here, consider this fact: To store 25,000 bbls. of propane at 210 psi would ordinarily require 25 mild carbon steel vessels. In contrast, only *one* large vessel made of T-1 steel of the *same* thickness would do the job. This single T-1 vessel would require 1/3 less shell material, 14% less foundation concrete, 70% less welding and 84% less space.

IN STEEL MILLS. In skip cars, T-1 steel in the bottoms, sides, and bail plates lasts three times longer than steels now in use. T-1 steel also gives exceptionally long service in coke bins and chutes, in ore transfer cars, in draft lines, in conveyor chains, and crane hooks. In clamshell buckets, T-1 steel has taken heavy abuse at temperatures from 500° to 600° F. and lasted *nine times* as long as the wear resisting steel previously used.

IN EXCAVATING EQUIPMENT. The dipper stick, bail, and bucket of this big electric shovel are fabricated of T-1 steel plate. The superior strength and durability of Carilloy T-1 made it possible to increase the capacity of the bucket from 35 to 45 cu. yds.

• The pressure vessel tests described on the previous pages indicate only one of the many possible uses of Carilloy T-1 steel. For this new engineering material has advantages not only in pressure vessels and storage tanks, but it also has proved itself in power shovels, bulldozers, mining machines, mine cars, steel mill ladles, blast furnace draft lines, lift trucks—in high speed rotating machinery, in stamping or forging presses. It is being considered for use in tension members of cantilever bridges and other similar applications where tension members are involved.

With the 90,000 psi. minimum yield strength to work with, combined with extraordinary sub-zero toughness, good high temperature strength to 900° F., and excellent resistance to impact abuse, impact abrasion, and atmospheric corrosion, you can use T-1 steel to reduce the size and weight of heavily stressed parts. This cuts your shipping and handling costs, as well as the cost of material, and the cost of foundations and supports where they are needed. Carilloy T-1 steel lengthens the life of your equipment, cuts repair bills and outage time. And remember, wherever you use T-1, you can weld or flame cut it either in the shop or in the field without expensive heat treating equipment. This cuts costs still further.

UNITED STATES STEEL CORPORATION, PITTSBURGH
COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO
TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA.
UNITED STATES STEEL SUPPLY DIVISION, WAREHOUSE DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

SEND COUPON FOR COMPLETE INFORMATION.

United States Steel, Room 4481
525 William Penn Place
Pittsburgh 30, Pa.

☐ Please send me your booklet "United States Steel presents T-1" which contains the full story of T-1 steel.

☐ Have your representative get in touch with me.

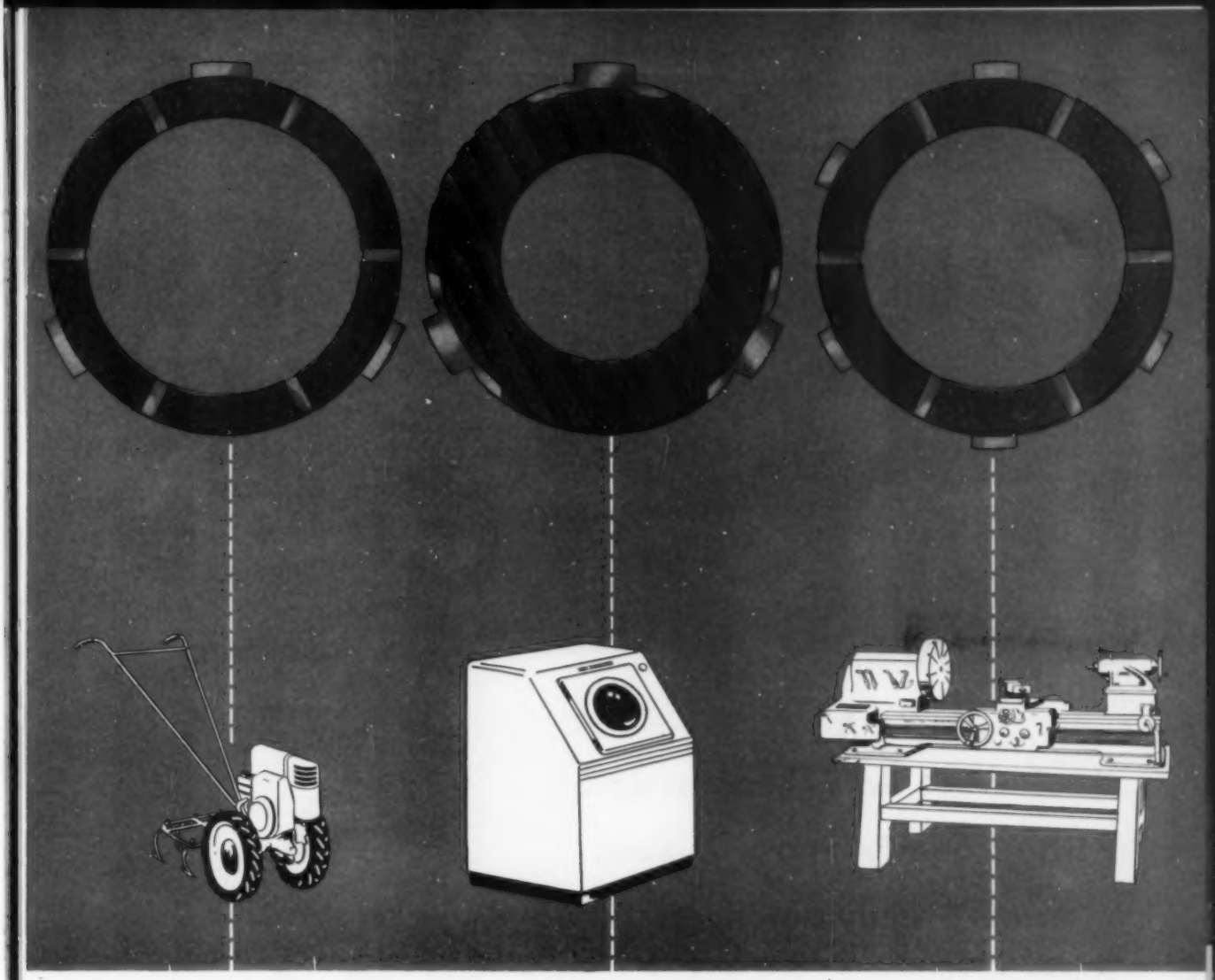
Name .....

Address .....

City ..... State .....

USS

UNITED STATES STEEL



Cork clutch facings are used in a wide variety of appliances and power equipment. Cork's high torque capacity at low engagement pressures often permits marked savings in clutch design.

CORK CLUTCH FACINGS:

Dependable performance for appliances and power equipment

Many manufacturers of appliances and other power equipment are getting efficient and dependable clutch performance from cork-compounded friction materials.

Cork's unusually high coefficient of friction makes it possible to transmit a given amount of torque with fewer or smaller plates. And the wide range of available cork friction compositions enables designers to get just the engagement characteristics and torque capacity they need for specific problems.

In wet clutch applications, cork's high torque capacity normally makes it possible to reduce the number of friction facings—or to use smaller plates—or to reduce engagement pressures, and still maintain the desired torque capacity. In such cases, the saving in material, metal, fabrication, and assembly can be substantial.

A good example of this is the experience of a manufacturer of automatic washers. By using cork composition, this manufacturer was able to reduce the number of friction facings from eight to three. But the real economy is in the service these facings give. They last the life of the appliance, eliminating expensive field maintenance.

If you're designing clutches for appliances, business machines, industrial equipment, or the automotive field, there's a good chance that cork's dependable performance and long life can help you. We'll gladly work with you in choosing the most efficient cork facing for your use. Write Armstrong Cork Company, Industrial Div., 7209 Irvin St., Lancaster, Penna.

ARMSTRONG'S FRICTION MATERIALS

Look what *You* can do with Alcoa Aluminum on your Acme-Gridley automatics

Free-machining Alcoa® Aluminum Screw Stock and your Acme-Gridley automatics form smooth-working, fast-working teams. They can knock out aluminum parts easily, cheaply and fast. With aluminum, you can take full advantage of Acme-Gridleys' direct, close-coupled camming and wide-open tooling zone features to thread, tap, ream or deep drill. High speeds and feeds are possible with good surface finishes and close tolerances, uniformly maintained.

Piece costs are much lower since you can get three times as many parts from a pound of aluminum as from a pound of heavier metals. In addition, they are excellent conductors of electricity and heat. Aluminum parts take all finishes and are highly resistant to corrosion.

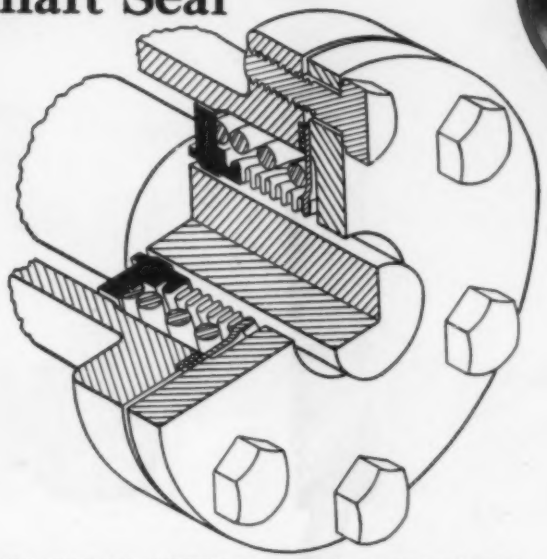
Find out for yourself what *you* can do with Alcoa Aluminum Screw Machine Stock. Contact your local Alcoa distributor or Alcoa sales engineer—your sources for Alcoa Aluminum and your short cut to experience in machining aluminum. Their offices are listed under "Aluminum" in the classified section of your telephone directory. Or, write ALUMINUM COMPANY OF AMERICA, 853-J Alcoa Bldg., Pittsburgh 19, Pa.

Alcoa offers *Alcoa Aluminum in Automatic Screw Machines*, a 95-page book containing information on tool design, setup and operating techniques. It is available to you at no cost just by writing on your company letterhead telling us your job function.

ALCOA ALUMINUM

ALUMINUM COMPANY OF AMERICA

How To Design A Bellows Type Shaft Seal



BELLOWS SHAFT SEAL ASSEMBLY is mechanically attached and sealed to shaft housing on one end. Seal nose at other end bears against shoulder on rotating shaft. The bearing surface of seal nose can be superfinished. Thrust is maintained by spring-action of the bellows, backed up by loading spring and remains constant regardless of pressure changes. Result: power output of shaft does not vary with pressure changes within the system. Wear occurs at an even, low rate. No tightening or take-up is required for the life of the seal.

Advantages of Bellows Seals

Pressure Problems Metallic bellows shaft seals have a long history of successful application in sealing shafts operating under fluid pressure conditions. A common example is their use in sealing the pump shafts of high pressure refrigeration systems.

By designing the seal nose and bellows to have equal effective areas, the thrust of the seal against the shaft face will remain constant and at a low value. Changes in internal or external pressures have no effect on the power output of the shaft and a tight seal is maintained.

Temperature Applications The all-metallic construction of bellows shaft seals make them effective over wide temperature ranges. In aircraft applications, bellows type seals operate under temperature extremes of —20F to 165F in pump shaft service. Even greater temperature ranges than these pose no problems for bellows shaft seals since they are not subject to deterioration due to heat and cold.

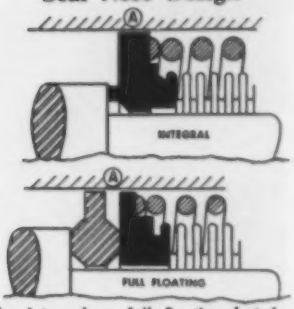
Shock, Vibration, Misalignment problems are frequently overcome by these seals because the bellows are inherently flexible and when a back up spring is incorporated in the design, they are ideal for such heavy duty applications as sealing torque converter shafts on trucks, military tanks and other large equipment operating under severe load conditions.

Corrosion Bellows shaft seals made of corrosion resistant metals such as stainless steels, monel, etc., greatly minimize corrosion problems. Several major manufacturers use them for sealing the shafts of gasoline and fuel pumps.

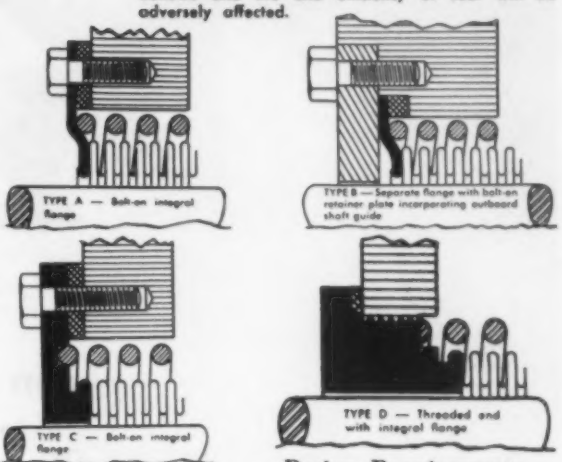
Shaft Preparation

The shaft to be sealed may either be turned down to provide a face for the seal nose to bear against, or a built-up ring may be provided. In either case the shaft face should be suitably finished for the intended service. (7.4.12)

Seal Nose Design

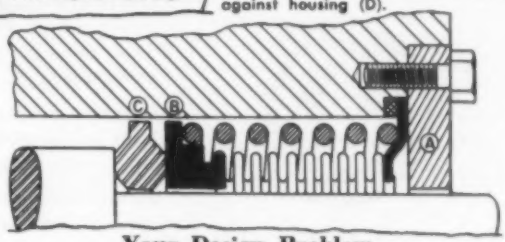


Seal nose can be integral or full floating but in either case guide the nose piece from the stationary member (shaft housing) as shown at (A). Full-floating design is best. It is poor practice to guide seal nose from shaft since vibration will be transmitted to bellows and life and efficiency of seal will be adversely affected.


TYPE A — Bolt-on integral flange
TYPE B — Separate flange with bolt-on retainer plate incorporating outboard shaft guide
TYPE C — Bolt-on integral flange
TYPE D — Threaded end with integral flange
TYPE E — Separate threaded flange

Design Requirements

The outboard end of the shaft seal must always be fastened rigidly to the stationary shaft housing and gasketed leak tight. Bellows should never be allowed to rotate with the shaft. Composite of good practice (below) shows use of an outboard shaft guide (A), nose piece guided against stationary housing (B) and use of full floating seal nose — also guided against housing (D).



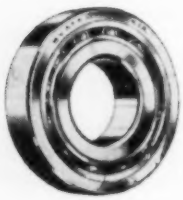
Your Design Problem

If you are faced with a shaft sealing problem, you can get help direct from Clifford. Simply sketch the controlling dimensions, types of seal ends desired and service conditions to be met. We will recommend a design to meet your requirements and produce seals in any quantity.

Write: Clifford Manufacturing Company. 122 Grove Street, Waltham 54, Massachusetts. *Division of Standard Thomson Corporation.* Sales Offices in New York, Detroit, Chicago, Los Angeles and Waltham, Mass.

Gas-Turbine-Powered Pump on Test at Navy Fire Fighting School

Where Hyatts turn at 40,000 rpm!



Old in theory, gas turbines are comparatively new as a practical power source. So it was big news in engine development when Solar Aircraft Company, of California, announced the world's first portable, hand-started gas turbine power plant.

Developing 50 horsepower, the new lightweight operates at the high speed of 40,000 rpm—or twenty times the speed of most automobile engines! And that's where we come in.

To be sure of complete bearing dependability for such high-speed operation, Solar turned to Hyatt . . . and there's a Hyatt Hy-Load Roller Bearing at the most critical position on the turbine shaft.

Whether you're building locomotives or lawn mowers, and whether shafts turn at 4 or 40,000 rpm, you'll get better bearing performance from *Hyatts!*

HYATT

ROLLER BEARINGS

STRAIGHT ◯ BARREL ◯ TAPER ◯

HYATT BEARINGS DIVISION ▪ GENERAL MOTORS CORPORATION ▪ HARRISON, NEW JERSEY

This Super Stainless Gives You New Freedom From Corrosion!

When you're faced with a severe corrosion problem, investigate the super corrosion resistance of Carpenter Stainless No. 20. This sulphuric acid resisting Stainless can often reduce shutdown time and add substantially to equipment life.

If you are familiar with this alloy in its cast form, known as Durimet 20*, you can appreciate Carpenter No. 20's superior resistance to sulphuric acids, plating and pickling solutions, mixed acids, etc. Now that Carpenter has solved the problem of producing this Stainless in rolled forms such as bars, wire, strip and tubing, the alloy is enabling industry to add months—even years to equipment life.

Many engineers tell us they're planning now to use No. 20 as soon as possible to improve corrosion resistance in their products and reduce shutdowns. For help in your product planning work get the new Carpenter Stainless No. 20 Book. In addition, start now to discover for yourself the far-reaching advantages of No. 20. We'll be glad to provide test coupons and work with your engineering staff. The Carpenter Steel Company, 117 W. Bern St., Reading, Pa.

Export Dept.: The Carpenter Steel Co., Port Washington, N.Y.
"CARSTEELCO"

Imagine What Corrosion Resistance Like This Can Mean To You!

The problem here was to find a material that would stand up in nozzles used to fill storage batteries with electrolyte. Special fixtures were used to handle 12% sulphuric acid (specific gravity 1.080) at temperatures from 70°F to 130°F. Hard rubber nozzles broke frequently—and shutdowns for replacement often ran as high as 30 minutes. Even 18-8 Stainless nozzles, while solving the breakage problem, corroded so badly they lasted only *2 weeks* (see 18-8 nozzle on right of photo). Then Carpenter No. 20 was put to work. After they had been in use for *many months*, nozzles made from No. 20 showed no signs of corrosion (see No. 20 nozzle on left of photo).

*Carpenter Stainless No. 20 is licensed under The Duriron Company, Inc., U.S. Pats. 2,134,670; 2,185,987 and 2,200,208.

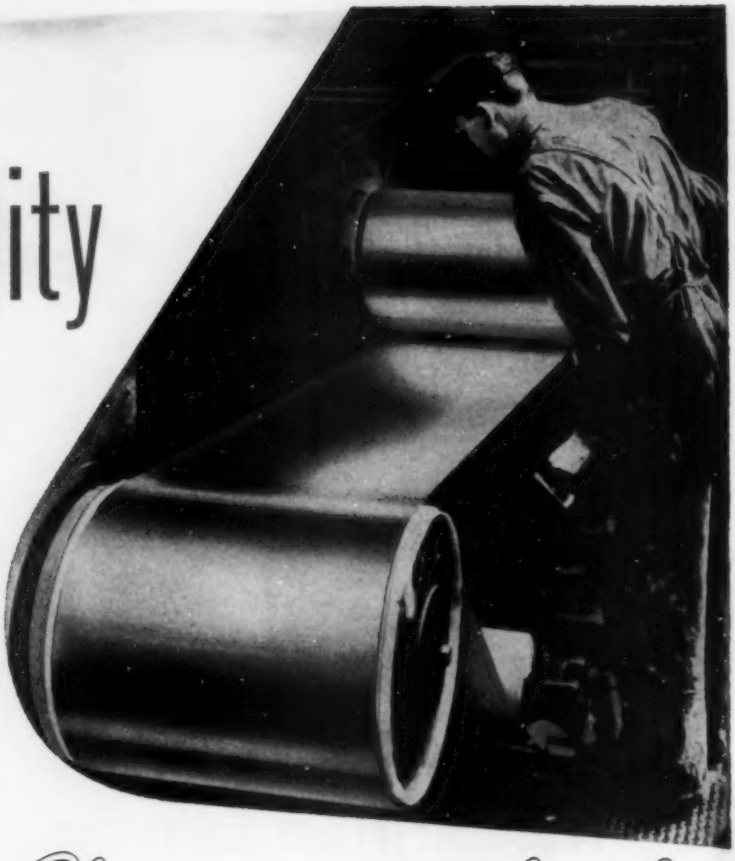
Contact The Carpenter Steel Company, Alloy Tube Division, Union, New Jersey, for Carpenter Stainless No. 20 in the forms of Tubing, Sheet and Plate.

more than corrosion resistance

Carpenter STEEL — Stainless No. 20

Pioneering in Improved Tool, Alloy and Stainless Steels Through Continuing Research

High quality finish



—helps make USS Amerstrip

America's preferred strip steel

The finest rolling equipment in the steel industry works for you when you specify USS Amerstrip. It enables us to supply you a *uniform* finish that exactly meets your specifications. Whether you need a dull finished surface for painting, a bright surface for electroplating, a galvanized or tinned surface for extra corrosion resistance, you can get it in Amerstrip. This wide range of high quality finishes is one reason why USS Amerstrip is more widely used in a greater variety of products than any other strip steel.

Amerstrip comes in a complete range of analyses and tempers in carbon, stainless, and alloy steels . . . in coils or cut lengths . . . with a round or square, natural or rolled edge.

If you have any question about the selection or use of strip steel, write to American Steel & Wire, Room 842, Rockefeller Building, Cleveland 13, Ohio. Our steel specialists will be glad to help you.

Amerstrip

CARBON • ALLOY USS STAINLESS

AMERICAN STEEL & WIRE DIVISION
UNITED STATES STEEL CORPORATION
GENERAL OFFICES: CLEVELAND, OHIO
COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO
TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA., SOUTHERN DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

UNITED STATES STEEL

For 50 Years....

THE WORLD'S MOST POPULAR SAFETY SWITCHES

COMPARE... LINE FOR LINE AND FEATURE FOR FEATURE

THEY COST NO MORE... WHY SETTLE FOR LESS?

ASK YOUR ELECTRICAL DISTRIBUTOR FOR SQUARE D PRODUCTS

SQUARE D COMPANY

MICRO SWITCH Precision Switches

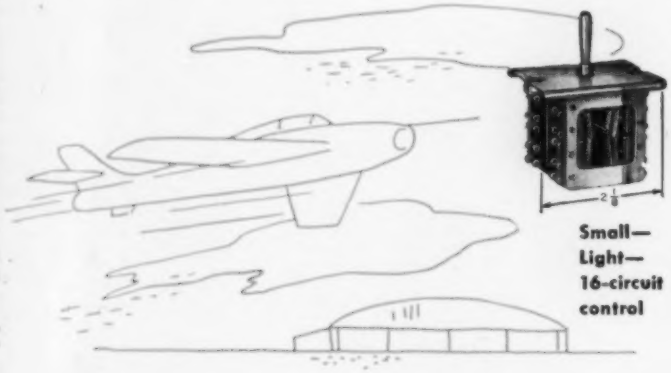
A PRINCIPLE OF GOOD DESIGN

Rugged—Housed—Water-tight

Gear hardening is an automatic job with the Westinghouse INDUCTALL. This machine heat treats 60 gears an hour with a completely automatic cycle of handling, heating, quenching and unloading.

Rugged, well-housed, easily mounted and with water-tight connections. MICRO SWITCH precision switches were selected by Westinghouse engineers to control each of these automatic cycles. Their performance enhances the reliability and long life of the machines.

A call to MICRO SWITCH has proved the solution to many knotty design problems. There is a branch near you.



Small—
Light—
16-circuit
control

What's on YOUR drawing board?

Few switch applications put more severe demands on small, light-weight components than those in aircraft. Reliability must go hand in hand with diminutive size.

Such a unit is the MICRO SWITCH 16-switch toggle-switch assembly picked by Republic Aviation engineers for accurate multiple circuit controls in the Thunderstreak jet fighter. Composed of 16 subminiature switches, it provides an efficient, compact and light-weight assembly to control as many circuits.

Do inches and ounces count in YOUR design problem? MICRO SWITCH has time-proved small switch assemblies to meet every type of actuation.

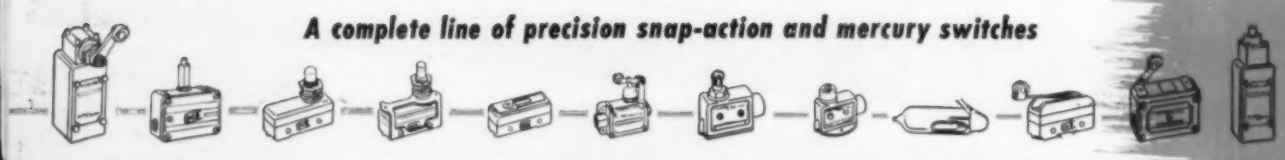
Safe interlock—
Fungus-proof—
Shock-resistant

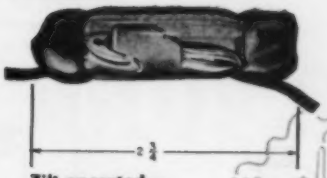
Navy electronic communications equipment operates in all climates and under all conditions. Components must be fungus- and corrosion-proof, operate in wide temperature ranges, withstand high humidity and be unaffected by extreme shock and vibration.

Because MICRO SWITCH engineering had previously developed a small, dependable door interlock switch for the protection of high voltage cabinets, the addition of these features to meet extreme operating conditions was not too difficult. In this double switch assembly, one switch turns off current when door is opened, the other flashes a warning if current should be turned on manually.

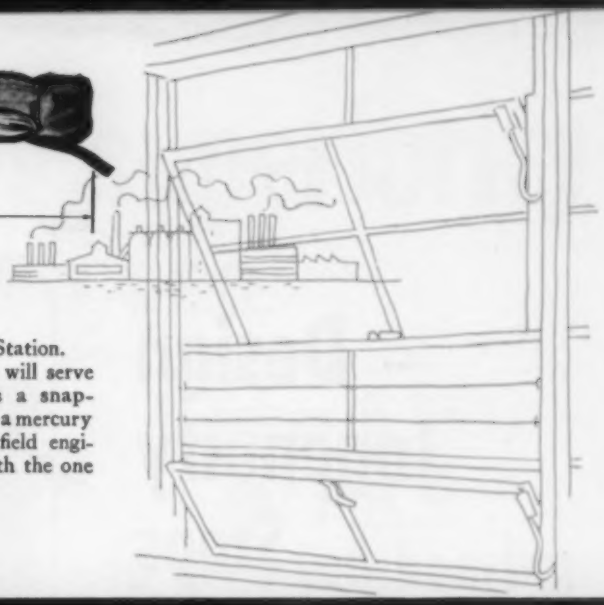
MICRO SWITCH may have already solved your switching problem for somebody else. A call to the nearest branch office could put you in production weeks sooner.

A complete line of precision snap-action and mercury switches





Tilt operated—
Low current—
Glass sealed



Burglar alarms aren't operated every day. When trouble comes, though, they must be ready. Glass-enclosed and completely protected from the elements, the Honeywell Mercury Switch has proved to be a good watchdog in certain types of alarm service.

Engineers of American District Telegraph Company selected Honeywell Mercury Switches as protective devices for buildings with tilt-type windows. Opening the window tilts the mercury in the switch to the activated position—the alarm rings in the nearest ADT Central Station.

What kind of a switch will serve YOU best? Perhaps it's a snap-action switch. Perhaps it's a mercury switch. MICRO SWITCH field engineers can provide you with the one you should have.

a machine tool? an elevator? jet aircraft? a burglar alarm? electronic equipment? or what?

Let a MICRO SWITCH engineer help you select the right precision switch!

Utmost reliability—
Positive action—
Millions of operations

Push button elevators use six to 24 MICRO SWITCH precision switches per elevator per floor, depending on the number of automatic functions.

Here's what the engineers of Montgomery Elevator Company, one of the largest elevator manufacturers, asked of a switch—millions of accurate repeat operations—positive snap-action opening and closing—absolute repetition of motion—long-life dependability.

They tested and selected MICRO SWITCH products and tell us they are glad they did. What is your switch application problem? Why not let a MICRO SWITCH field engineer work on it with you? It will cost you nothing—may save important time.

MICRO SWITCH provides a complete line of extremely reliable, small-size, high-capacity, snap-action precision switches and mercury switches. Available in a wide variety of sizes, shapes, weights, actuators and electrical characteristics. For all types of electrical controls.

MICRO SWITCH
A DIVISION OF MINNEAPOLIS-HONEYWELL REGULATOR COMPANY
FREEPORT, ILLINOIS

H HONEYWELL

Design Ingenuity Stops Bathroom Jiggling

"Alert" Tank Ball and Guide solves a problem that has plagued millions for a generation — the leaky, noisy toilet. All metal parts are made of corrosion-resistant Monel to assure long, trouble-free performance with this ingenious design.

Diagram showing how "Alert" Tank Ball and Guide is installed in toilet tank. Installation takes only ten minutes. Plastic cylinder guides ball down onto seat accurately. Made by Ardmore Products Co., Conshohocken, Pa.

Probably every household is bothered at times by a "runny" toilet tank.

Once let the conventional arrangement of wires, guides and ball-spindle get just a trifle out of adjustment, and the water gurgles and splashes until someone jiggles the handle. Or else takes off the tank cover and re-seats the ball by hand.

A designer of surgical appliances had his rest disturbed by a noisy toilet tank just once too often. So he tore out the tangly wires, did away with the shifty wire guides, and substituted a hollow plastic tube and a round rubber ball suspended on a non-kinking chain.

But he didn't stop there. He realized there were several spots where even this simple device *could* fail or get out of kilter. One was the hook, chain and insert in the ball to which the chain is fastened. He foresaw how corrosive attack or wear might cause them to weaken and break.

The other two spots were the two riveted clamps with their spring grips that hold the plastic tube firmly in alignment. If they weakened or lost their spring properties, the tube could become dislodged.

To guard against failure in those three spots, he specified strong, corrosion-resistant Monel.

The device worked so beautifully he decided to make it commercially. The result is the famous "Alert" Tank Ball and Guide described in newspapers and popular magazines.

Perhaps the experience of this designer reminds you of some application in which metal failure has been bothering you. If so, Monel or one of the other Inco Nickel Alloys may prove a ready solution to your problem.

A concise description of the useful properties and characteristics of these alloys is included in a handy booklet, "Standard Alloys for Special Problems." A copy is yours for the asking.

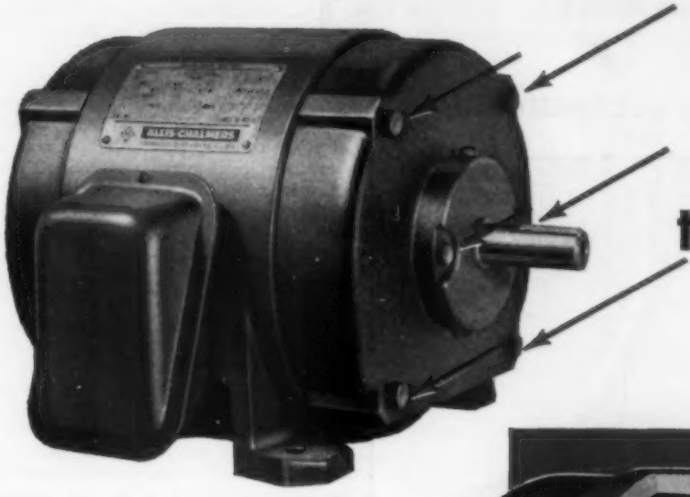
The INTERNATIONAL NICKEL COMPANY, Inc.
67 Wall Street, New York 5, N. Y.

INCO TRADE MARK **NICKEL ALLOYS**

MONEL® • "R"® MONEL • "K"® MONEL • "KR"® MONEL • "S"® MONEL
INCONEL® • INCONEL "X"® • INCONEL "W"® • INCOLOY®
NIMONIC® Alloys • NICKEL • LOW CARBON NICKEL • DURANICKEL®

Here's motor superiority

you can see

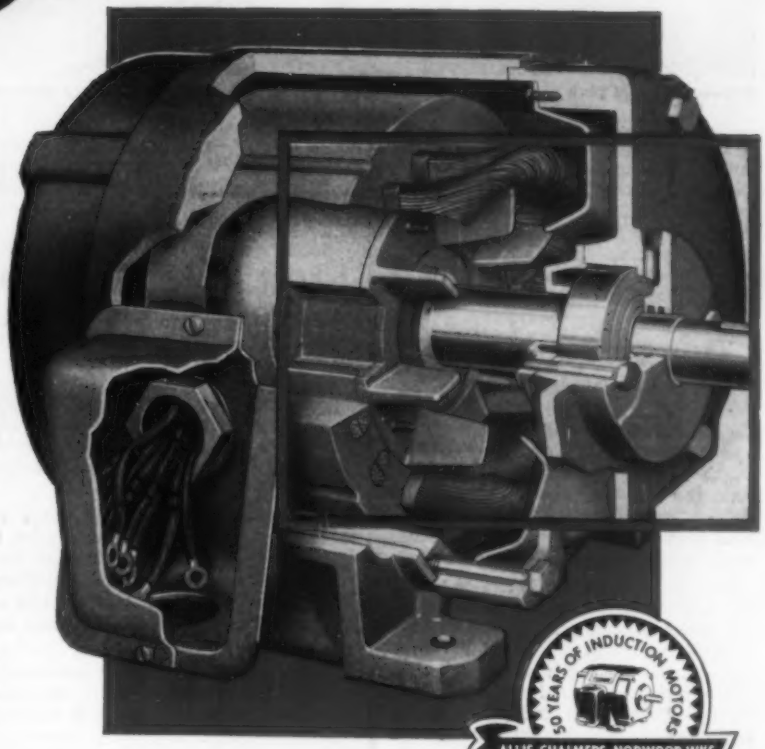


It takes 6 bolts not just 4 to give full bearing protection

THE TWO EXTRA BOLTS in the end housing of every Allis-Chalmers ball bearing motor are the proof of *extra* protection against bearing failure. These are the bolts that hold the bearing cap tightly in place against the inner face of the bearing enclosure. This cap, with its close running clearances, keeps grease from the interior of the motor . . . retains an ample supply within the bearing enclosure . . . protects the grease and the bearing against contamination from dirt and moisture.

At the outer side of the bearing, double labyrinth seals keep grease in, also keep dirt out. What's more, large grease reservoirs act as additional dirt traps.

Result? Allis-Chalmers motors pay off in longer, trouble-free bearing life, lower motor maintenance.



Get all the facts . . . judge for yourself — Compare Allis-Chalmers motors with other motors. Get the six-bolt construction that gives you complete bearing protection. For proof, see your Allis-Chalmers Office or Authorized Distributor, or write — Allis-Chalmers, Milwaukee 1, Wisconsin.

ALLIS-CHALMERS

A-C ALLIS-CHALMERS

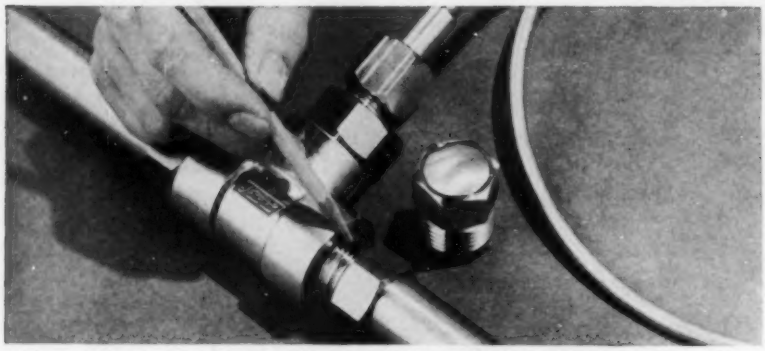
A-4440

BRIDGEPORT BRASS COMPANY

COPPER ALLOY BULLETIN

Bridgeport Brass Co. MILLS IN BRIDGEPORT, CONN. AND INDIANAPOLIS, IND.—IN CANADA: NORANDA COPPER AND BRASS LIMITED, MONTREAL

Quality Metals Control High-Pressure Gas



Differential thread pitch on bushing allows solid joining of nipple and socket. (Courtesy National Welding Equipment Co., San Francisco, Calif.)

High-pressure cylinder manifolds must be completely leakproof, especially when handling highly flammable or explosive gases, such as oxygen, hydrogen, or acetylene. One manifold achieves reliability and flexibility by combining a new design made of Bridgeport High I.Q. (Inner Quality) Brass.

The system includes a manifold socket, a nipple and a bushing. The socket and nipple are threaded to different pitch, while the bushing is threaded inside and out to match respectively the nipple and socket. To make a joint, the bushing is screwed onto the nipple, then screwed into the socket. The differential threading pitch will produce a positive high-pressure metal-to-metal seat inside the socket.

Backbone of the manifold system is Bridgeport high-strength metals. The manifold socket is forged from Bridgeport Brass Forging Rod (Alloy 133) for superior strength and toughness. The nipple is turned from Bridgeport Free-Turning Brass Rod (Alloy 6) for high-speed machining with minimum tool wear. And the bushing is made from Bridgeport Aluminum Silicon Bronze Rod (Alloy 707) for exceptionally high strength and corrosion resistance.

Bridgeport High I.Q. (Inner Quality) alloys are engineered for top performance in both fabrication and service. The next time you need an alloy for faster production, lower costs and longer service life, call on Bridgeport. Our Technical Service will be glad to help you select the right combination of strength, grain size, temper or machinability to improve your products.

Cold Heading Saves Metal, Cuts Cost

Cold heading can be a real money saver in producing precision metal parts. First, waste from cold forming is virtually zero compared to machining the same piece from solid stock. Second, many cold-headed parts can readily be used in the as-formed state since finishes are smooth and bright and tolerances are close.

For unusually high tolerances or slight changes of shape, machining is generally slight and such secondary operations as milling, slotting, drilling, tapping, threading or knurling can be done easily at high speeds ideal for mass production.

Third, cold-headed parts are usually made from metals specially produced for cold working, and the forming operation itself is a 100% check on quality. Any defect in the metal would show up quickly during upsetting. Finally, with sound metals cold forced into dies their grain structures closely follow the contour of the part, increasing its strength and resistance to vibration and shock.

Among the many Bridgeport alloys specially produced for cold heading is Bridgeport Yellow Brass (Alloy 16), often chosen for its double suitability to cold heading and machining. Bridgeport Silicon Bronze (Alloy 609) is recommended for cold forming bolts with exceptionally large heads. Its tensile strength runs up to 100,000 psi and its corrosion resistance is excellent. For extra-fine work, soap-drawn wire can be extruded to micrometer exactness.

Your plans for cold heading will hinge on selecting the alloys with the right combination of tensile strength, finish, grain size and temper.

And in selecting the right alloy—you'll find Bridgeport's Technical Service an invaluable help. Whether it's an alloy for cold-heading parts, brass for a band instrument or any one of hundreds of uses, Bridgeport's 89 years of metalworking experience and skill are always available to help you use metals to better advantage. Call our nearest sales office for prompt, dependable service on your metal needs.

Brass For The Band

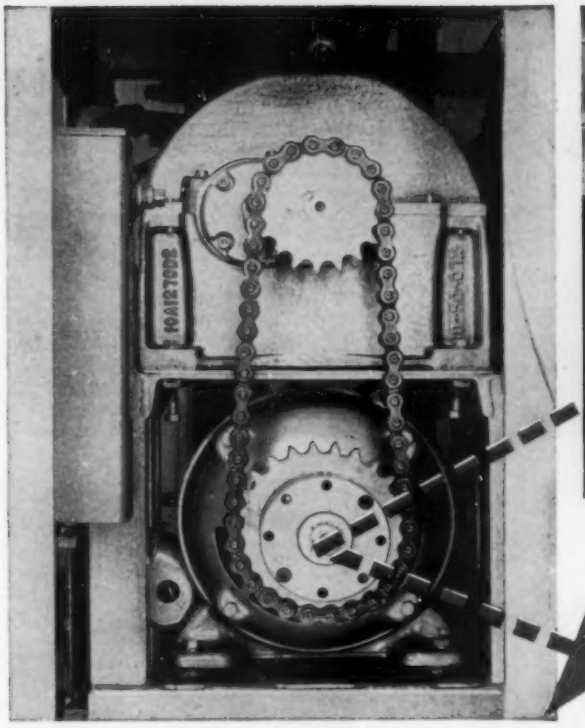
Sheet brass helps put the oompa in a brass band. High-quality metal produces true pitch and tone. (Courtesy C. G. Conn, Ltd.)

Many a bright summer day has been brightened still more by the rollicking notes from a brass band. From trumpets to tubas, the proud parade of music-makers sounds its notes on horns made up from 654 different raw materials, of which fine sheet brass is by far the most important of them all.

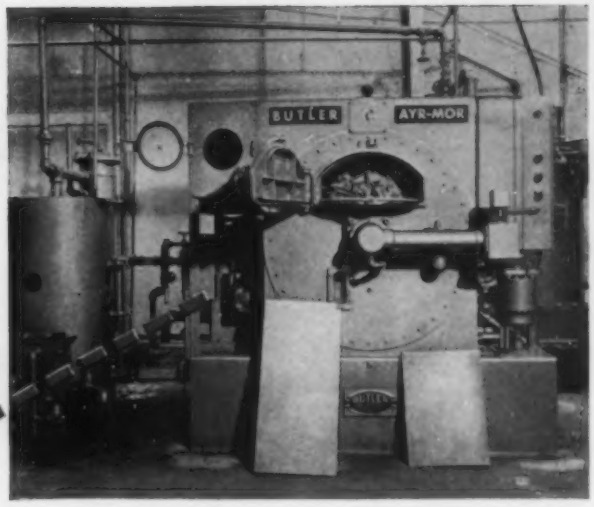
The customary metal used for band horns is Low Brass, 80% (Bridgeport Alloy 5) furnished in 16 to 20 gage metal, usually of soft temper. Another alloy used for horn parts is Cartridge Brass (Bridgeport Alloy 37).

Just as the making of music and the instruments that produce it are arts, so too is the making of brass. That's why the skill and years of metalworking experience that go into Bridgeport Alloys enable them to meet the high standards of the instrument industry.

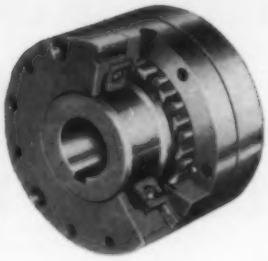
(1921)



Butler Built Ayr-Mor Two Bath Synthetic Unit Drive Assembly uses Morse Cam Clutch and flexible, precision-built Morse Roller Chain.



Butler Ayr-Mor Two Bath Synthetic Unit, panels removed



Cutaway view of adaptable Morse Cam Clutch

Morse Cam Clutches make possible unique two-speed drive

Two motors—the extractor and the washer—provide the main drive on the Butler Built Ayr-Mor automatic washers. The 1-hp, 1750-r.p.m. washer motor is equipped with a speed reducer having output speed of 100 r.p.m. It is mounted directly above a 3-hp, 1640-r.p.m. extractor motor. The washing-tumbling speed of the drum is 33 r.p.m., and the extracting cycle speed is 575 r.p.m.

The two motors are interconnected by a Morse Cam Clutch and Morse Roller Chain, so that the washing motor utilizes the shaft of the extractor motor while in the washing-tumbling cycle. When the extracting motor takes over, the overrunning Morse Cam Clutch automatically releases the washing motor.

Morse Cam Clutches are available in 5 design types, transmitting fractional to over 6000 foot-pounds and covering almost the entire range of known design requirements. The one type Series-200 Cam Clutches are furnished without inner races; can be mounted directly on shafting for indexing, overrunning and backstop applications; are as adaptable as 200-Series ball bearings.

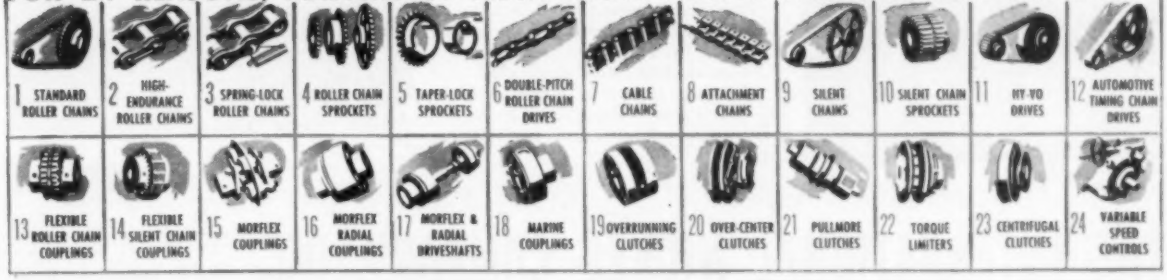
Send now for the new Morse Cam Clutch Catalogue. For further information on how Morse Power Transmission products can help you in your design applications, contact your local Morse distributor. Or, write:

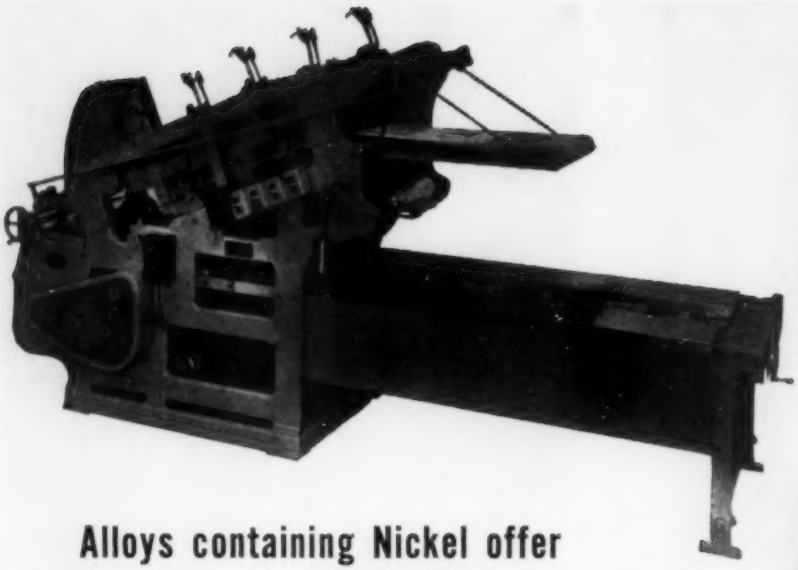
MORSE CHAIN COMPANY
7601 Central Avenue
DETROIT 10, MICHIGAN

MORSE

MECHANICAL
POWER TRANSMISSION
PRODUCTS

FOR 24 REASONS, MASTERS OF MECHANICAL POWER TRANSMISSION SINCE 1893





STAINLESS STEEL CONTAINING NICKEL resists attack by chemicals and atmospheres over a wide range of concentrations, pressures and temperatures. At elevated temperatures it resists oxidation, yet retains toughness and high strength down to —400°F. Easy to clean and keep clean, chromium-nickel stainless steel is used extensively by Package Machinery Co., of East Longmeadow, Mass., in the manufacture of the bacon packaging machine shown here and other food handling equipment.

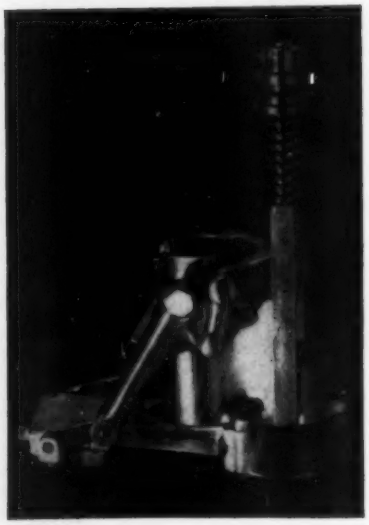
Alloys containing Nickel offer

almost any combination of properties you want

SHOWN HERE are only four of hundreds of different combinations of properties. They give wider play to the skill of the engineer.

You can save weight and provide better durability, and frequently also improve response to fabrication . . . by using appropriate alloys containing nickel. Send details of your metal problems for our suggestions, Write us today.

NICKEL CAST IRONS combine improved strength along with other desired properties such as resistance to heat and wear. The many types available allow you to specify thermal expansion, pressure tightness, machinability and the like. Typical of nickel iron performance, these melting pots cast by C. H. Milles Foundry Company, Chicago, Ill., for use at elevated temperatures, outlasted plain iron pots by 60%.



←——CAST NICKEL SILVER

bottle cappers produced by Universal Casting Corp., of Chicago, Ill., are easy to cast or fabricate, machine and polish. This durable alloy combines corrosion resistance and lustrous beauty. Ease of fabrication and maintenance make it ideal to increase product acceptance and cut costs, too.

HERE'S NICKEL STEEL——→

that withstands thousands of impacts per minute. It's a carburized grade used in hammer, anvil and arbor of an Ingersoll-Rand Impactool, shown here, bolting up an assembly. From the many standard grades of nickel alloy steels available, you can readily choose one with the best combination of properties for both fabrication and end use.

EMBLEM OF INCO SERVICE

THE INTERNATIONAL NICKEL COMPANY, INC. 67 WALL STREET NEW YORK 5, N. Y.

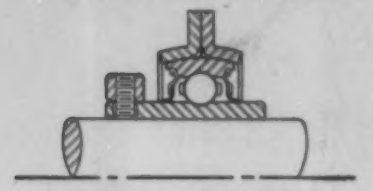
Link-Belt JPS-200 ball bearings are standard equipment on Scott Urschel beet harvester.

BEARING PROBLEM?

READY ANSWER:

Series JPS-200 Ball Bearing Pillow Blocks are part of Link-Belt's line of pillow blocks, flanged, flanged cartridge, cartridge, hanger and take-up blocks and unmounted bearings.

MAXIMUM SEALING EFFICIENCY. Synthetic rubber lip-type seal, integral with bearing, retains lubricant and excludes dirt. Greased at factory, bearing requires no further lubrication.



UNRESTRICTED SELF-ALIGNMENT. Enclosed aligning surfaces allow free fitting between outer ring and housing. Full load capacity is maintained regardless of shaft deflection or misalignment.

New, low-cost LINK-BELT precision ball bearing combines efficiency, economy

COST has often prohibited use of ball bearings on light-duty equipment. But no more! With Link-Belt's new JPS-200 Series, you get all the advantages of precision anti-friction bearing performance at low cost. The sturdy, pressed steel housing permits economy without sacrificing performance.

Designed for applications where speeds are relatively low and loads are light, JPS-200 bearings incorporate a precision, deep-groove, single-row ball bearing, assuring smooth operation and freedom from wear. They're available for ⅝ to 1¼-in. shafts.

Whether it's low speeds with light loads . . . heavy duty under abrasive conditions—whatever the application—there are Link-Belt ball and roller bearings that meet every requirement. For all the facts on industry's most complete line of mounted and unmounted ball and roller bearings, ask your Link-Belt office or authorized stock carrying distributor for Data Book 2550. And for complete information on the new JPS-200 ball bearing, write for Folder 2517.

LINK-BELT

BALL and ROLLER BEARINGS

LINK-BELT COMPANY: Executive Offices, 307 N. Michigan Ave., Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices, Stock Carrying Factory Branch Stores and Distributors in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World.

13,842

Sealing trailers at the seams

3M COMPANY

When you consider the amount of weathering to which a house trailer is exposed in the course of its service, you can appreciate the importance of effective, all-around sealing.

Finding a seal to keep out dust, weather and noise used to present a real problem. But it doesn't any longer—thanks to 3M's new ribbon-like sealer, EC-1202. Made of synthetic rubber, EC-1202 is extremely flexible and easy to handle. And it's reinforced with sturdy fabric so that it holds its dimensions and is exceptionally easy to apply.

On trailers, like the one pictured above, EC-1202 is used to seal metal corners and edges. Next, an extruded aluminum corner is bolted over it for extra protection, to provide a complete seal against weathering of all sorts.

See what adhesives can do for you . . . You can use EC-1202 wherever metal corners, edges, or faying surfaces need sealing. Your 3M sales engineer will give you all the facts on this and other 3M adhesives developed for industry. Call him, or write today for free informative booklet—to 3M, Dept. 49, 417 Piquette Ave., Detroit 2, Mich.

see our catalog in PRODUCT DESIGN FILE or write for copy

ADHESIVES AND COATINGS DIVISION **MINNESOTA MINING AND MANUFACTURING COMPANY**

417 PIQUETTE AVE., DETROIT 2, MICH. • GENERAL SALES OFFICES: ST. PAUL 6, MINN. • EXPORT: 122 E. 42 ST., N. Y. 17, N. Y. • CANADA: LONDON, ONT.

MAKERS OF "SCOTCH" BRAND PRESSURE-SENSITIVE ADHESIVE TAPES • "SCOTCH" BRAND SOUND-RECORDING TAPE • "SCOTCHLITE" BRAND REFLECTIVE SHEETINGS • "3M" ABRASIVE PAPER AND CLOTH • "3M" ADHESIVES AND COATINGS • "3M" ROOFING GRANULES • "3M" CHEMICALS

A service for

early birds

engineering new metal products

... early birds
are sheet metal design engineers and production men who make a point of getting the gremlins out of new products or new models in early stages ...

If you're an EARLY BIRD, here's a new service you'll appreciate.

It starts when engineers of National Lead's Tool & Stamping Department go over your designs, looking for production bugs and ways to cut costs.

Next step is to cast try-out tooling, in "Kirksite" A or "Nalcolite" plastic ... and to make up the parts in the stock you want.

After that, National Lead assembles pilot models ... as many as you want.

Once dies, parts, and pilot models are proved to your satisfaction, the try-out tooling goes to you for medium-run production or for duplication in steel when you plan extremely high production.

By the time you're ready for full scale production, every procedure, every cost is *proved*.

Just chirp up if you would like to know more about this new Tool & Stamping Department service.

National Lead Company

900 West 18th Street
Chicago 80, Illinois

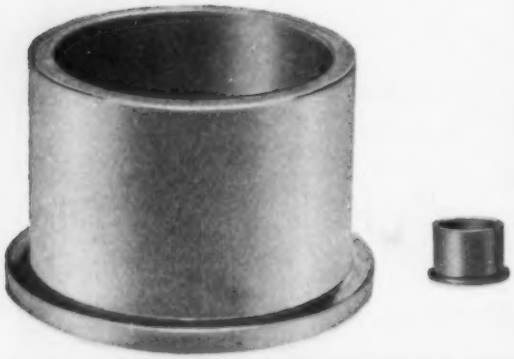
TOOL & STAMPING DEPARTMENT

BIG OR LITTLE . . . TOUGH OR EASY

GRAMIX® SINTERED METAL PARTS

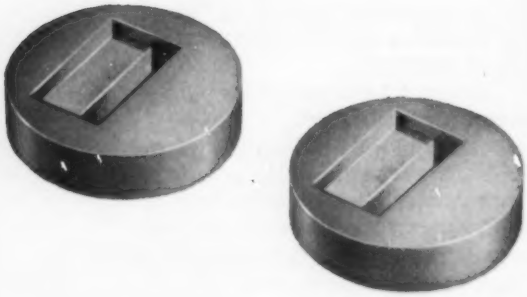
PRODUCED TO EXACTLY MEET ANY REQUIREMENTS

large and small pieces

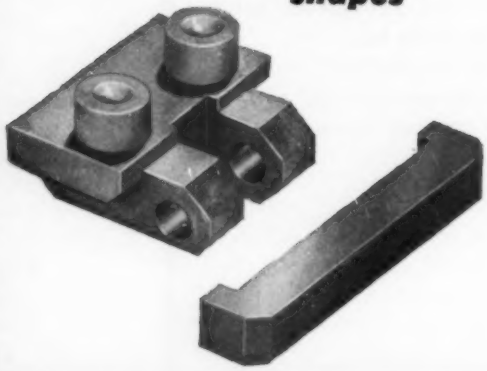


open or close tolerances

single and multiple compositions



simple or complex shapes



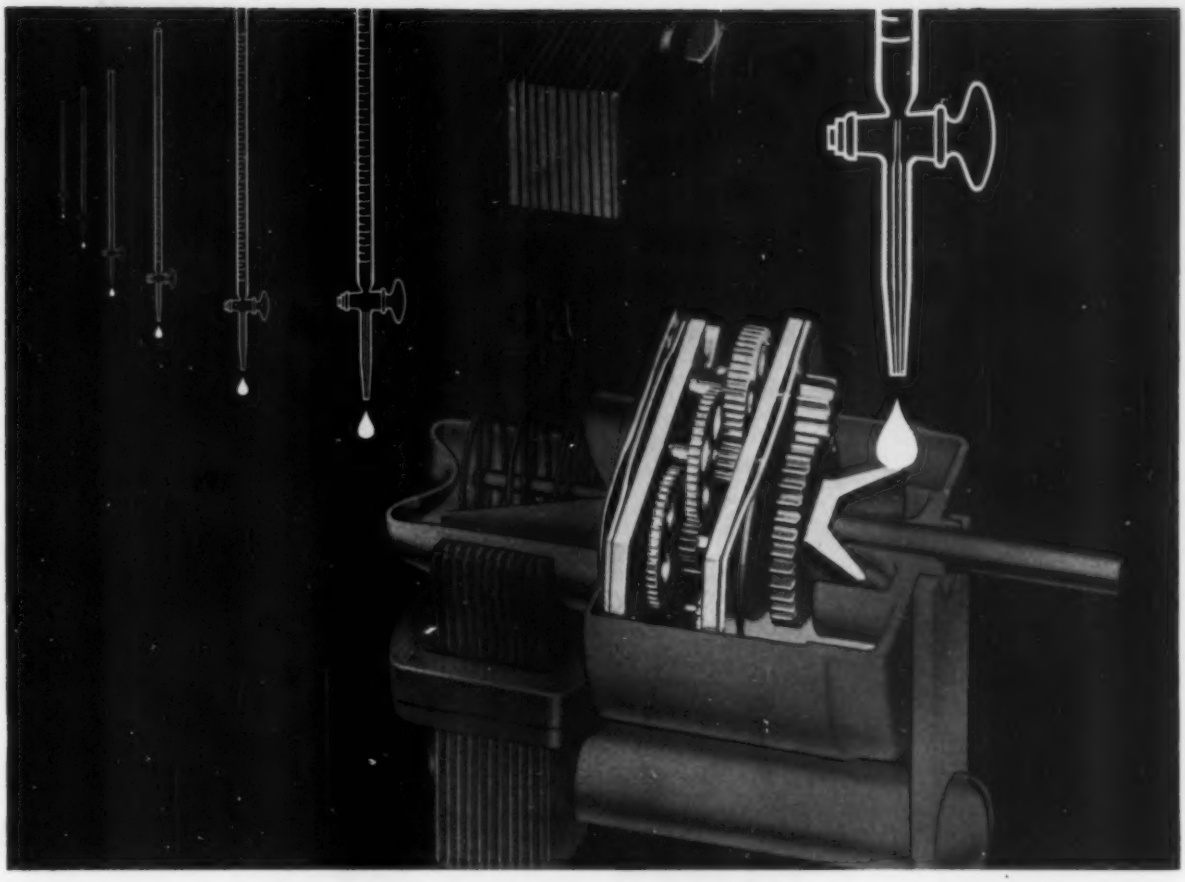
104

GRAMIX sintered metal bearings and parts can be produced to meet an extremely wide variety of applications and specifications. Even intricate shapes of close tolerances save considerable money as against similar parts machined from bar stock. With simple compositions and shapes not close in tolerance the costs are amazingly low. In addition our competent engineers will study the prints you submit and recommend the correct composition and design considerations to most practically and economically manufacture your parts. There is no obligation for this service, of course. Write for data book.

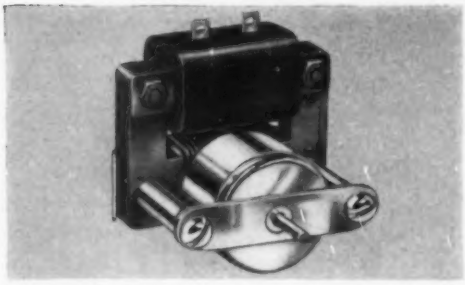
OUR 100th YEAR

THE UNITED STATES GRAPHITE COMPANY

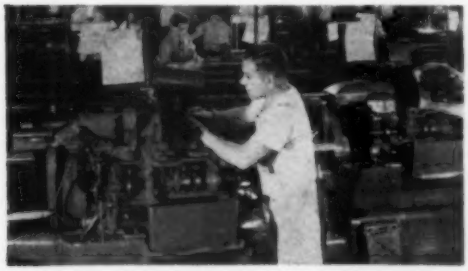
DIVISION OF THE WICKES CORPORATION • SAGINAW, MICHIGAN



MORE evidence of the extra VALUE in TELECHRON timing motors...



Telechron motors play a major part in switching many of America's jobs to "automatic." They are unmatched in the field of electric timing with such features as lightweight rotors for instant starting... open-air design for cool running... and truly synchronous performance.



Big production by our automatic screw machines—typical of our large motor plant capacity—plus an experienced engineering staff, assure speed in deliveries.

CONTROLLED, SEALED-IN LUBRICATION LASTS THE LIFE OF THE MOTOR

Too much oil interferes with a timing motor's accuracy. Too little causes excessive wear. The key factor in the instant starting and long life of a Telechron timing motor is its unique controlled system of lubrication.

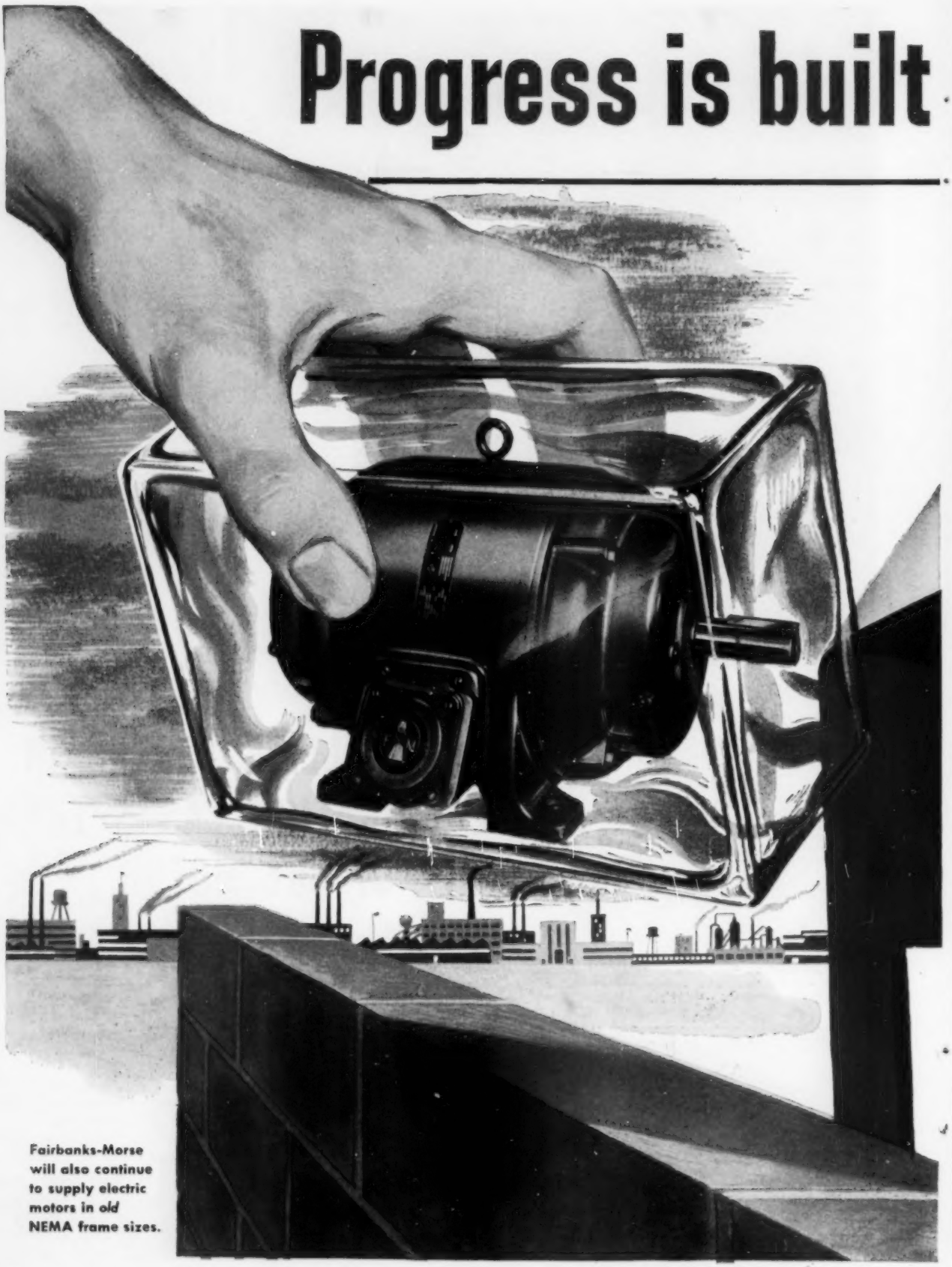
Each Telechron motor carries a lifetime reservoir of oil sealed in its rotor unit. Capillary action carries the oil to bearings, where its flow is controlled to all moving parts.

This exclusive lubrication system is one reason why—rating for rating—a Telechron timing motor will outlast and outperform any other synchronous timing motor made.

Telechron timing motors come in a wide range of speeds and torque ratings, for any standard AC power source. Write for full details about our Application Engineering Service. Telechron Department, General Electric Co., 19 Homer Ave., Ashland, Mass.

Telechron®
MARK OF TIMING LEADERSHIP

Progress is built



Fairbanks-Morse will also continue to supply electric motors in *old* NEMA frame sizes.

t ....brick by brick

The new NEMA Standard for electric motors is a significant sign of progress to all industry—More Power in Less Space.

But progress—to be lasting—must be built brick by brick For more than a century, Fairbanks-Morse designers have held to the ideal of more performance in less space. They have produced outstanding advancements in the design of diesel engines, pumps, scales, locomotives and the many other products that feature F-M exclusives. Fairbanks-Morse electric motors built on this basic F-M engineering philosophy are continuing assurance of operating economy and efficiency.

Look for the electric motor that stands on this Fairbanks-Morse solid foundation of design progress. It carries the Fairbanks-Morse Seal of Quality.

NEW FAIRBANKS-MORSE GUARDED DRIPPROOF MOTORS

1 Guarded, dripproof construction keeps falling objects and dripping liquids out of motor in any mounting position—maximum motor protection under conditions of wet or dirty operation—indoors or out.

2 Exclusive Fairbanks-Morse feature that provides a virtually indestructible one-piece rotor—homogeneous, free from flaws and gas inclusion for maximum strength and lifetime service.

3 Oversized, precision ball bearings in spacious housings, sealed against grease leakage. Contain ample lubrication for extended periods of rugged service. Convenient flushing and re-lubricating available if desired.

4 F-M exclusive design eliminates hot spots. Cooling outside air is drawn into motor through openings in lower portion of both bearing arms and circulated through cored passages in the frame.

5 New, gasketed, cast iron conduit box permits easy pulling of cables without insulation damage. Fairbanks-Morse exclusive: recess feature allows elimination of conduit box where space is limited.

FAIRBANKS-MORSE
a name worth remembering when you want the best

ELECTRIC MOTORS AND GENERATORS • DIESEL LOCOMOTIVES AND ENGINES • PUMPS • SCALES • RAIL CARS • HOME WATER SERVICE EQUIPMENT • FARM MACHINERY • MAGNETOS

THE DOOR TO BETTER PRODUCT *performance*

IS OFTEN A *screen* DOOR!

You don't *see* the industrial wire cloth in every motor car and truck. But, it's there. In the small parts—to make them *big* in performance. In air cleaners, brake lining, oil and fuel strainers, and so on.

And, if it's Reynolds, it's *the* wire cloth that gives superior service satisfaction. It puts precision performance in precision parts.

From metal to mesh . . . from wire to weave . . . from ductility to durability . . . Reynolds is the wire cloth of precise specifications—*your* specifications.

Reynolds 60-year-long experience can match your wire cloth needs. Because Reynolds has progressed with the automotive industry—and all industries, from agricultural to home appliance applications.

Consult Reynolds engineers . . . no cost . . . no obligation

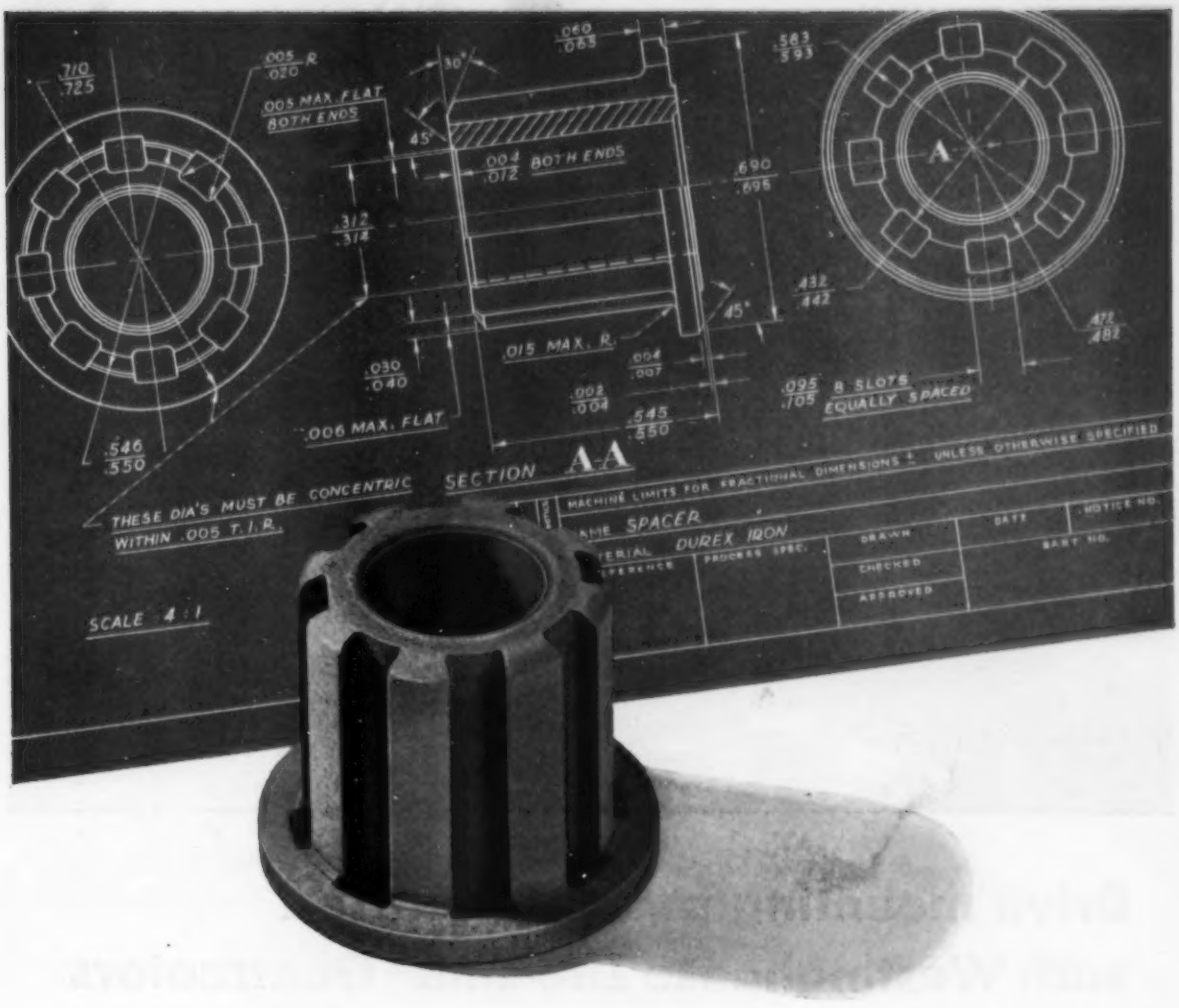
Reynolds WIRE CLOTH for Industry

NS NATIONAL-STANDARD Company NILES, MICHIGAN

REYNOLDS WIRE DIVISION, NATIONAL-STANDARD CO., Box 200, **DIXON, ILL.**

Divisions of National-Standard Co.

ATHENIA STEEL...*Clifton, N. J.*	Flat, High Carbon, Cold Rolled Spring Steel
NATIONAL-STANDARD...*Niles, Mich.*	Tire Wire, Fabricated Braids and Tape
WAGNER LITHO MACHINERY...*Jersey City, N. J.*	Metal Decorating Equipment
WORCESTER WIRE WORKS...*Worcester, Mass.*	Round and Shaped Steel Wire, Small Sizes



TRICKY DESIGNS ARE EVERYDAY PROBLEMS FOR MORAINE'S METAL POWDER PROCESS

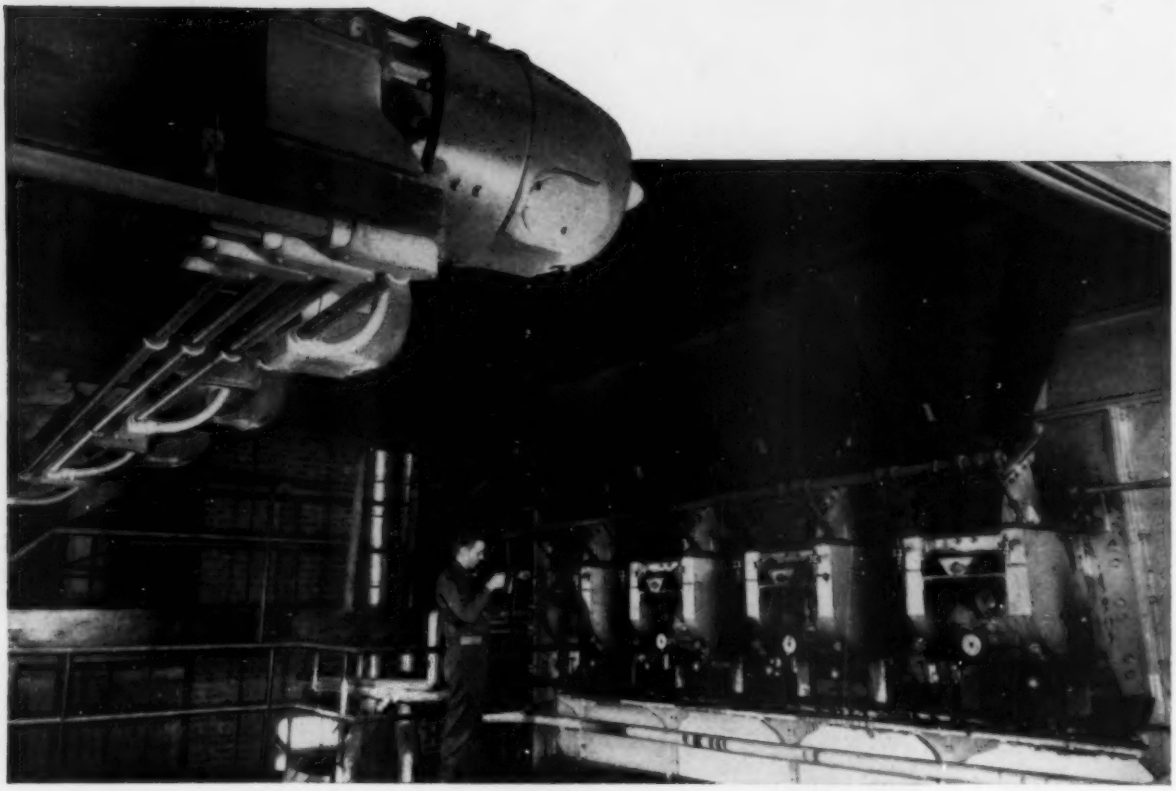
This part would be a *real* problem to make economically by conventional casting and machining methods. At Moraine it's made from metal powder—easily, in quantity, every day—to precision standards—with important savings in cost!

The background print shows clearly the intricacies and the close tolerances demanded by this part. Yet at Moraine it is produced *completely finished* after *one* press operation. Here's proof of what can be done through close cooperation between Moraine and customer.

The contributions of Moraine's metal powder process to industry are growing day by day. Complex designs like this are being produced by Moraine with great performance-improving, cost-cutting results for many customers.

m moraine products
DIVISION OF GENERAL MOTORS CORPORATION, DAYTON, OHIO

METAL POWDER PARTS



Drive mounting problems erased with Westinghouse *Life-Line** Gearmotors

Putting the best drive in the minimum space is a problem constantly facing design engineers. In answer to this problem, Westinghouse Life-Line Gearmotors provide unit compactness, rugged construction and job-proved efficiency.

Westinghouse Life-Line Gearmotors have both motor and gears designed as an integral unit. As a result, there's a major saving in space because all belts, chains and pulleys can be eliminated. This means no alignment problems. Since integral design lessens the number of wearing parts, over-all maintenance is cut to a minimum.

With split-case gearmotors, there's no need to allow large work areas for removal or dismantling—all servicing can be done with the gearmotor "on the job". Split-case construction permits the gear cover to be removed in minutes and makes all working parts readily accessible. Any servicing, therefore, becomes a simple, speedy operation.

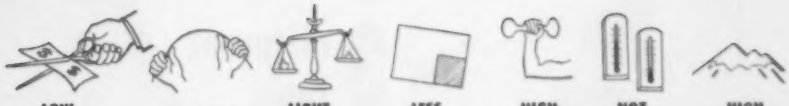
Taper-hardened gear teeth, thorough lubrication and industry-tested Life-Line Motors are but a few of the features which assure long, dependable performance from Westinghouse Gearmotors.

Your local Westinghouse Representative will gladly furnish you with additional information. Call him at any time or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pa. *Trade-Mark J-07322

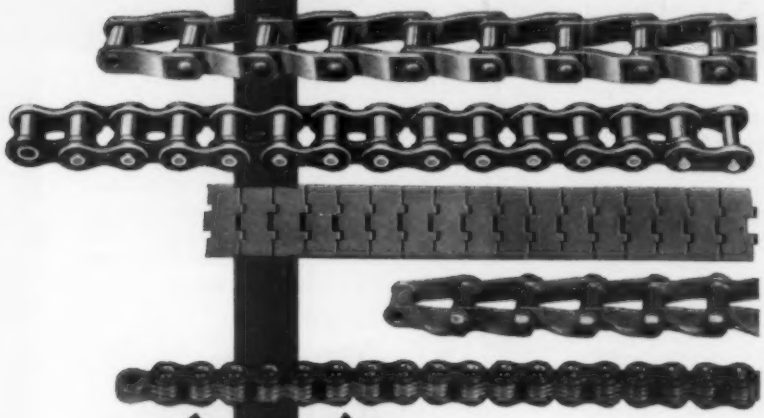
YOU CAN BE SURE...IF IT'S Westinghouse

des n your machines

with these dvantages



t only CHAINS give you!



Your Chain Belt Field Sales Engineer will be happy to help you select the size and type of chain and sprocket that will best suit your needs . . . provide the most efficient drive or conveyor at the lowest cost. Call him or mail the coupon today.

Always the one best chain for each service **CHAIN BELT COMPANY**

CHAIN BELT COMPANY
4715 W. Greenfield Ave.,
Milwaukee, Wisconsin

54-501

I want information on chains for.....
Send literature on: ☐ Chabelco Chains; ☐ Roller Chains; ☐ TableTop; ☐ Leaf Chains; ☐ Cast Chains; ☐ Sprockets. ☐ Have a Chain Belt Man call.

Name.....

Company.....

Address.....

City.....*Zone*.....*State*.....

Die Casting

enables **1** maker to use the same **2** parts for **3** different tools

CASE HISTORIES FROM MT. VERNON FILES

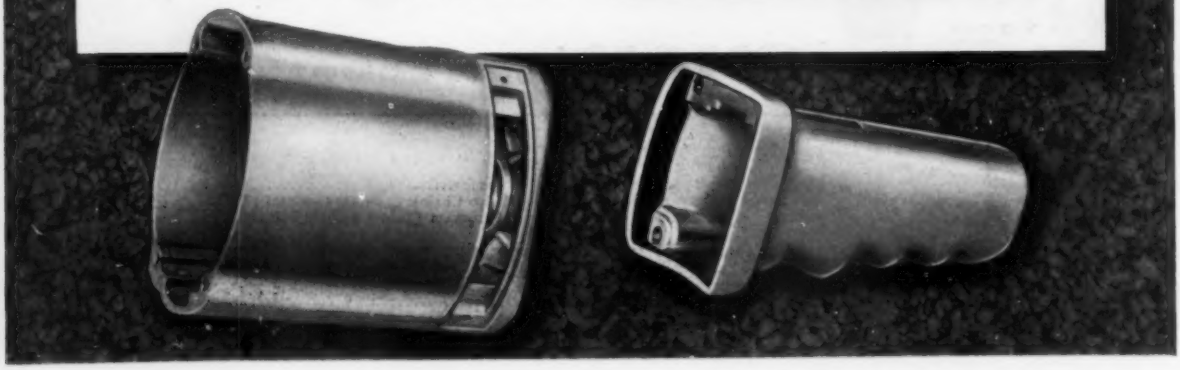
While we have introduced the economies of die casting to manufacturers in many fields, it strikes us that Millers Falls Co., Greenfield, Mass., comes closer than most to gaining the *maximum* benefits from making die cast parts interchangeable.

Among the varied line of quality electric tools they make are the three units shown above: (A) The No. 404 Portable Electric Grinder; (B) The No. 270 Polisher; (C) The No. 870 Industrial Sander. In each of these tools two identical Mt. Vernon die cast parts serve as motor housing and handle. The two parts are fastened together at different angles—but think of the savings in labor, savings in time, savings in inventory!

Other advantages inherent in these die-cast parts are light weight combined with strength to withstand the vibration and pounding these tools receive—also, even with intricate designs such as these, die casting is done to such close tolerances that machining is minimized.

Whatever *your* product, you can almost certainly profit by considering the advantages of die casting: light weight, simplicity, lower costs. Our varied experience of many years is wholly at your service. Let us know your needs today.

MT. VERNON
DIE CASTING CORP.
STAMFORD, CONNECTICUT



dependable shut-off control

for high flow capacity systems

fuel
oil
air
water
alcohol
coolants

One-piece cast aluminum body eliminates gasket and body-joint leakage.
High-flow capacity valve for fuels, oil, air, water, alcohol and coolants.
Meets all standard and proposed AN specifications for fuels and gases.
Operating time: ½ to 1 second on sizes to 2"; 1 to 2-plus seconds on sizes over 2"
Manual override for operation at valve location, retains the visual positioning feature.
Clutch limit control permits use of conventional motor with exact "on-off" positioning.
Thermal relief, by-passing the gate in either direction, is optional.
Special seals on both sides of slide gate insure tight shut-off in either direction.
Gate type: elliptical slide —hardened stainless steel.
Thermal relief of body cavity
Positive drive clutch of controlled type.
Valve movement can be instantly reversed at mid-point.
Full-port, full-flow types in 1" to 4" tubes: Pull-out types up to 2" tubes. Other types and other sizes available on order.
Ambient temperature: —65° to 160°F.
Operating pressure: 0 to 100 psi.
Helicoil inserts.
Floating "O" ring retainer (removable)
CONTROLS
VALVE

General Controls hi-g® Gate Valves have interchangeable actuators: motor-driven, manual, motor-driven with manual override, or splined shaft for cable or lever operation. The AV-16B, above, a motor-driven valve with 12 "g" acceleration factor, has planetary reduction gearing, positive drive clutch, internal cutout and signal light switches, and a visual valve-position indicator. Other valves of the versatile hi-g® family include limit controls, 3-way and 4-way selector valves. Efficiently designed with one-piece cast aluminum bodies, trouble-free shut-off control for high flow capacity aircraft systems.

General Controls

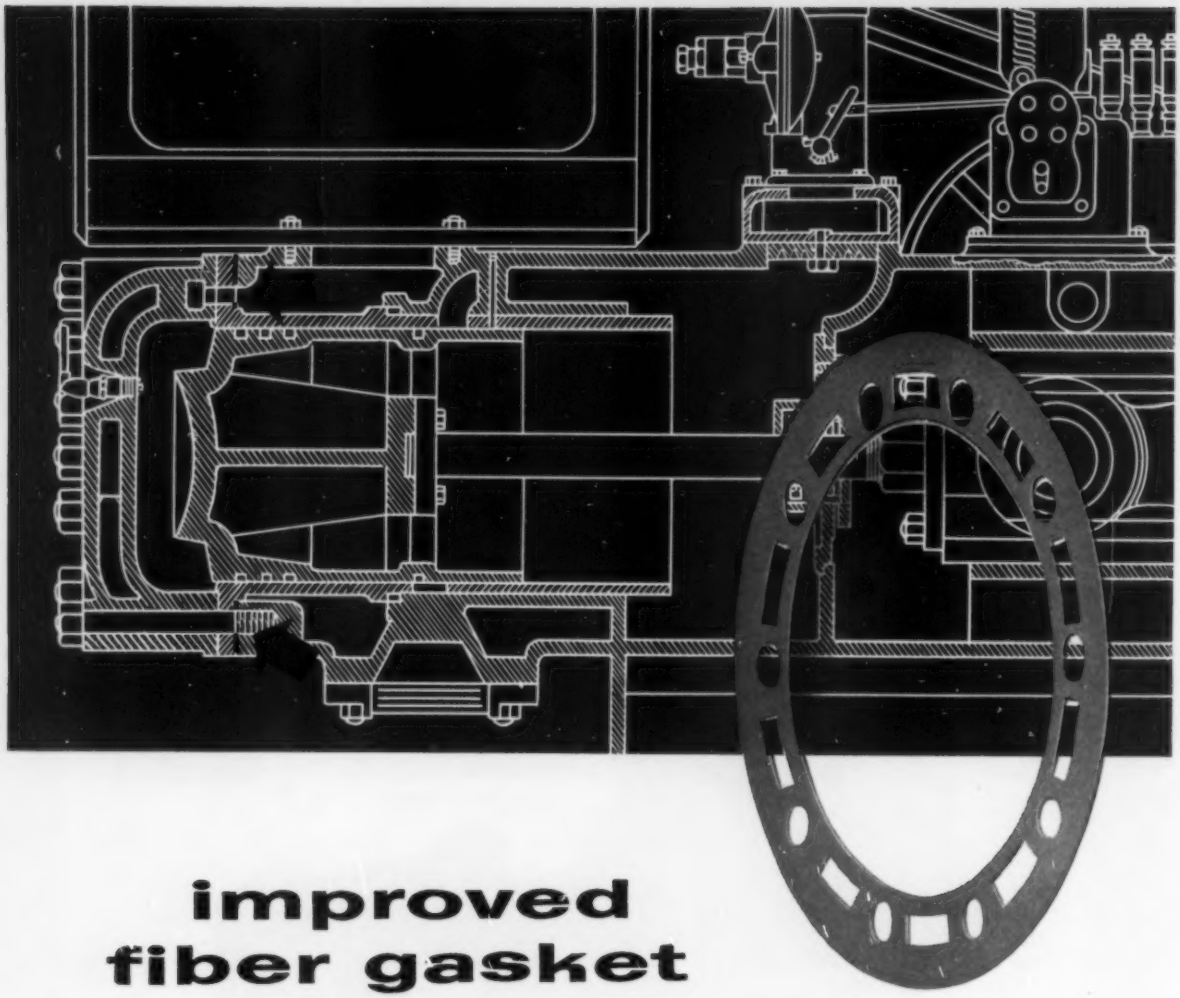
AV-16

hi-g® gate valves

GENERAL CONTROLS

PLANTS IN: GLENDALE, CALIF., BURBANK, CALIF., SKOKIE, ILL.
FACTORY BRANCHES IN 37 PRINCIPAL CITIES
SEE YOUR CLASSIFIED TELEPHONE DIRECTORY

Manufacturers of Automatic Pressure, Temperature, Level and Flow Controls for Heating, Home Appliances, Refrigeration, Industrial and Aircraft Applications.



improved fiber gasket

makes engine re-design unnecessary

Choosing the right gasket material may be a critical factor in the success of a product design, as the manufacturer of an oil field engine discovered.

In his engine, the lateral expansion of the cylinder sleeve tends to force the cylinder head away from the block. Conventional fiber gasket materials lacked sufficient "kickback" to adjust to that expansion. It seemed for a time that this shortcoming would force the engine manufacturer to abandon his design.

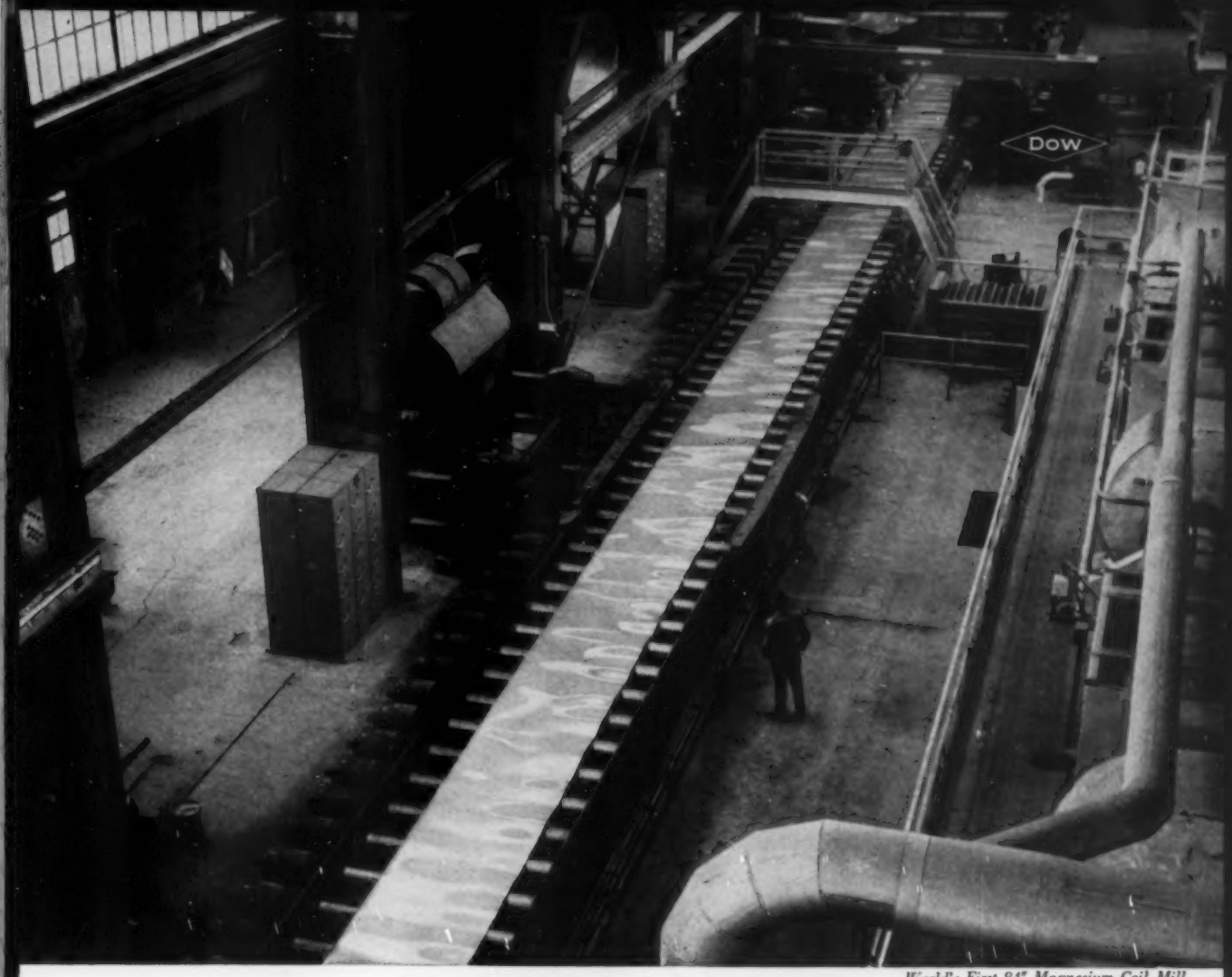
Then he tried a new type of fiber gasketing—Armstrong's Accopac®—and the leaks vanished. Since Accopac CN-705 gaskets became standard, not one case of gasket failure has been reported.

Accopac seals tightly because of the way it's made. A patented beater saturation method blends fiber, cork, and rubber into uniformly strong, homogeneous sheets that are unusually compressible. The latex rubber binder is non-volatile and non-extractable. This makes Accopac remarkably resistant to dimensional change under varying humidity and temperature conditions.

For dependable, low-cost sealing—try Accopac. It's used in everything from pumps and air compressors to aircraft, automotive equipment, and household appliances.

FREE 24-PAGE GASKET MANUAL—See "Armstrong's Gasket Materials" in Sweet's product design file. Contains information on Accopac as well as other types of gasketing materials, plus data on joint and gasket design. For your personal copy, write Armstrong Cork Co., Industrial Div., 7009 Irvin Street, Lancaster, Penna.

ARMSTRONG'S ACCOPAC



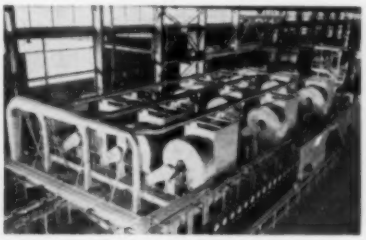
World's First 84" Magnesium Coil Mill.

a new look at Magnesium!

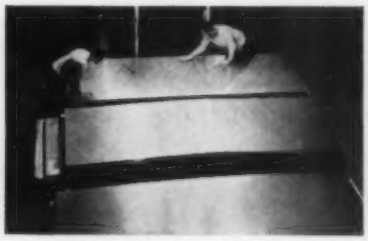
UP TO 25% PRICE REDUCTION ON SHEET AND PLATE

New Dow facilities—now in operation—are producing magnesium sheet in *quantity*. Wider, longer—magnesium sheet now offers a brand new challenge to designers, engineers, manufacturers. To cut costs, to save weight, to add strength—to do revolutionary new things for many products—get the new magnesium story! Call the nearest Dow sales office or write THE DOW CHEMICAL COMPANY, Magnesium Department, Midland, Michigan.

Here for the first time, large magnesium rolling ingots weighing nearly a ton are being rolled.



Specially designed, carefully controlled ovens pre-heat huge magnesium ingots just before rolling.

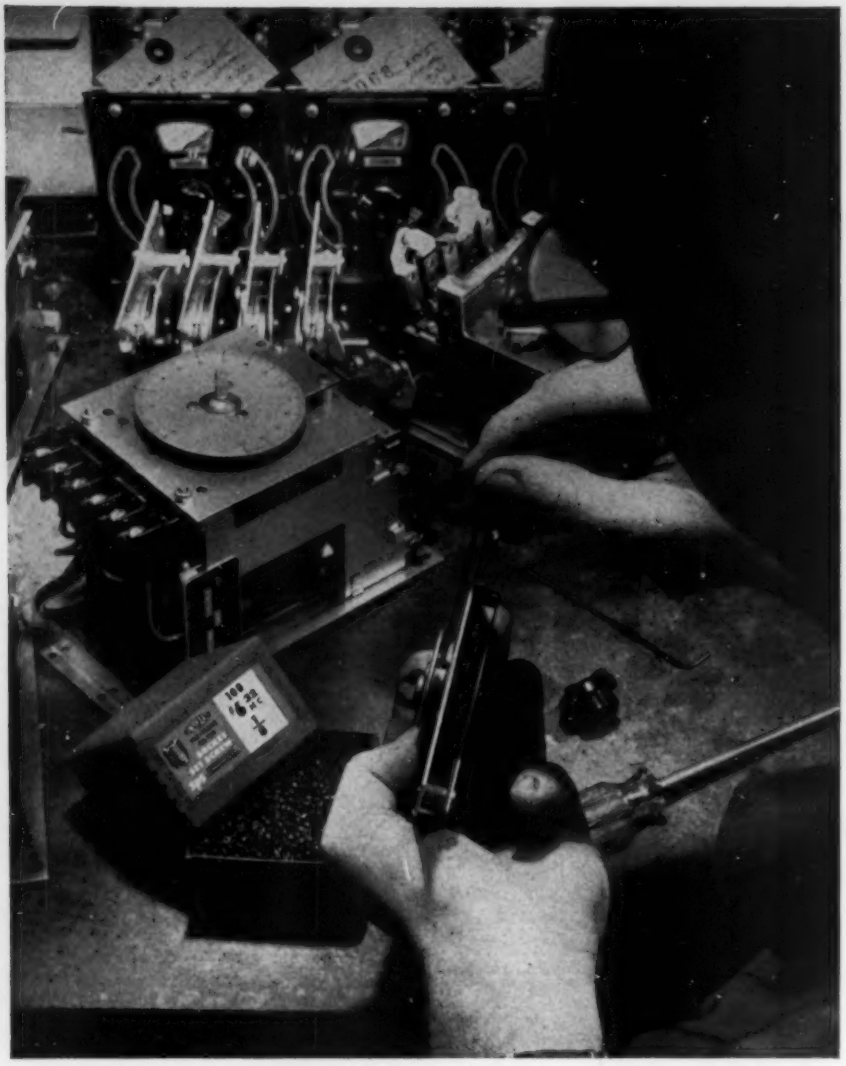


Constant inspection plus rigid production controls assure uniform magnesium sheet quality.

Note how coil of magnesium sheet illustrates new availability in greater widths and lengths.

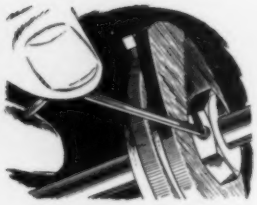
you can depend on ***DOW MAGNESIUM***

DOW



UNBRAKO Self-Locking Socket Set Screws are used to hold the Vernier-Set or Cycle-Progress cam on the shaft of this precision timing device. Once they are tightened, they maintain the accurate setting so important to the operation of the instrument.

Because they are so tiny, the UNBRAKO set screws are picked up and started in the tapped hole with the long arm key.



The compactness of the design of the timing device makes it necessary to turn the screw in prior to assembly. The uniform depth and size of the hex socket permit maximum torquing, speed assembly.

UNBRAKOs—made of heat treated alloy steel—have fully formed threads, Class 3 fit; have knurled cup point for positive locking. Are available in standard sizes from # 4 to 1".

You can lower your inventory by using UNBRAKO Standards—stocked by your distributor

You'll have less money tied up in inventory, you'll get personalized service, faster deliveries. In addition, you'll reduce assembly time and increase production with these precision industrial threaded fasteners. Write for UNBRAKO Standards—a complete listing of socket screw products made by SPS and stocked by your local distributor. STANDARD PRESSED STEEL Co., Jenkintown 28, Pa.

UNBRAKO® SOCKET SCREW DIVISION SPS JENKINTOWN PENNSYLVANIA

we "threw away the book" to make this die casting . . .

● Thin walls blending into heavy sections made this a tough one . . .
but **Stewart** turns out castings like this in volume

After 44 years, Stewart Die Casting is still young enough to have new ideas. When conventional methods are not good enough, we "throw away the book" and find a way. Whatever type of die castings you need – small or large, simple or intricate – count on *Stewart* to meet your most rigid specifications . . . on time.

SERVICES AVAILABLE . . .

Designing • Engineering • Die Making
Metallurgical Control • Most Modern Die Casting Equipment • Complete Machining, Polishing and Assembly Facilities.

44 years of helping industry to "Make It Better"

Stewart DIE CASTING

. . . a division of STEWART SW WARNER

CHICAGO, ILLINOIS, 4535 FULLERTON AVENUE • BRIDGEPORT, CONNECTICUT, 275 WARREN STREET

. . . for less than you can yourself!

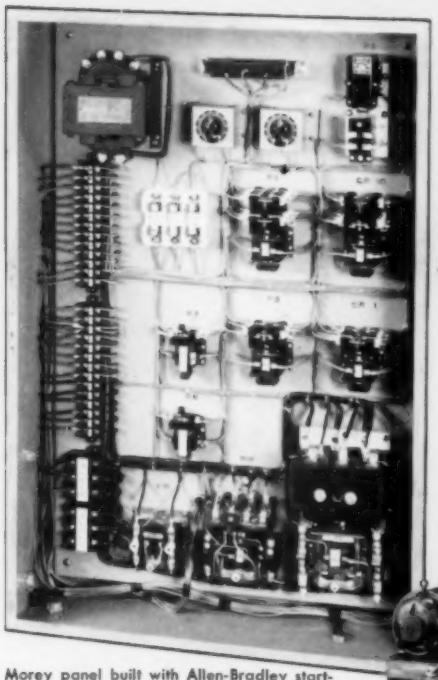
Our plants produce over 10 million small precision pieces every day—in the temper, hardness and micro-finish our customers require—to tolerances in tenths. What's more, we can make them *faster, better, and for less* than you can yourself.

Let us quote on your requirements. A letter outlining your needs plus a sample part or blueprint will receive prompt attention. If you desire more information, we'll be glad to send our Condensed Catalogue which illustrates many more of the parts we can produce quickly and economically.

THE TORRINGTON COMPANY
Specialties Division
230 Field Street, Torrington, Conn.

TORRINGTON SPECIAL METAL PARTS

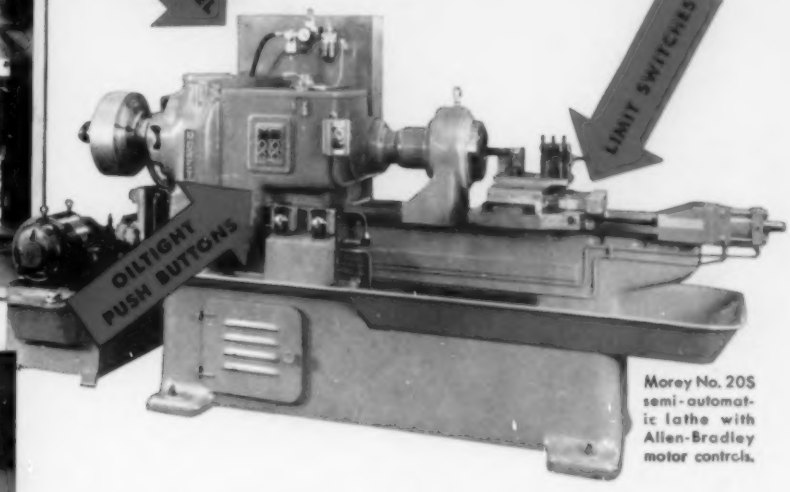
Makers of Torrington Needle Bearings



Morey panel built with Allen-Bradley starters, relays, timers, and terminal blocks.

Bulletin 802T Type D oiltight limit switch.

Three Bulletin 802T oiltight limit switches on Morey semi-automatic lathe for limiting travel of tool holder.



Morey No. 20S semi-automatic lathe with Allen-Bradley motor controls.

Close-up of Bulletin 800T oiltight push buttons on Morey lathe. They control spindle and pump motors.

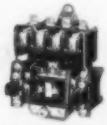
Add a Sales Asset to your Machine Tools by standardizing on A-B MOTOR CONTROLS

With the growing trend toward AUTOMATION, electric motor controls are items of critical interest to machinery buyers. They recognize the A-B trademark as a label of QUALITY for the Allen-Bradley starters, relays, contactors, timers, drums, limit switches, and push buttons. So, why not standardize on Allen-Bradley motor controls and enjoy the benefits of a prestige line of quality control units? It will not only assure reliable performance of your machines but add another touch of quality appearance . . . a distinct sales asset.

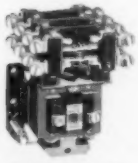
An Allen-Bradley sales engineer will gladly recommend the best combination of controls for the maximum output of your machines. Why not phone your nearest Allen-Bradley office, today?

Allen-Bradley Co., 1316 South Second St., Milwaukee 4, Wisconsin

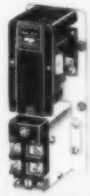
Bulletin 709 Size 2 solenoid starter.



Bulletin 709 Size 1 solenoid starter.



Bulletin 700 solenoid relay—Universal type.



Bulletin 849 pneumatic timing relay.

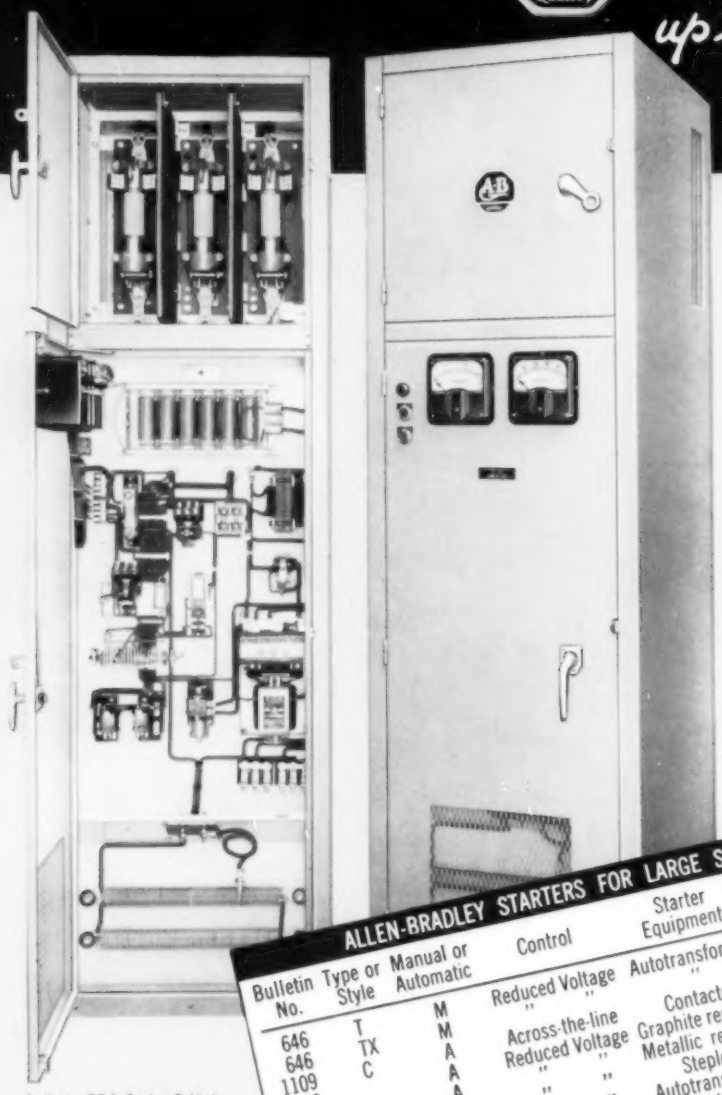
ALLEN-BRADLEY
QUALITY
MOTOR CONTROL

A-B Quality

8-54-R

LIFETIME A-B STARTERS

up to 1500 HP



Bulletin 906 Style C high voltage synchronous motor starter with current-limiting fuses. Self-protecting against short circuits up to 150,000 kva on 2500 volts or 250,000 kva on 2501 to 4600 v. The high tension, solenoid operated, across-the-line oil-immersed switch is mounted in oil tank behind the panel. Cabinet has hinged doors on front and back.

There are 14 different types of these rugged Allen-Bradley starters. (See listings below.) Some are of the across-the-line type . . . but most of them are reduced voltage starters using resistors, transformers, or reactors during the starting period.

These starters are available in 2500 to 4600 volt ratings for squirrel cage motors from 700 to 1250 hp, and for synchronous motors from 800 to 1500 hp. They are listed for squirrel cage motors from 125 hp, 220 v to 600 hp, 440-550 v, and for synchronous motors from 350 hp, 220 v to 700 hp, 440-550 v.

For complete details, please send for the A-B Handy Catalog.

ALLEN-BRADLEY STARTERS FOR LARGE SQUIRREL CAGE MOTORS

Bulletin No.	Type or Style	Manual or Automatic	Control	Starter Equipment	Maximum Horsepower at Rated Voltage 220V	440-550V	2000-2500V	2501-4600V
646	T	M	Reduced Voltage	Autotransformer	125	250	700	1250
646	TX	M	" "	"				
1109	C	A	Across-the-line	Contactor	200	200		
740		A	Reduced Voltage	Graphite resistors	300	600		
741		A	" "	Metallic resistors	300	600		
742		A	" "	Stepless	300	600	700	1250
746	CT	A	" "	Autotransformer				
1146				"				

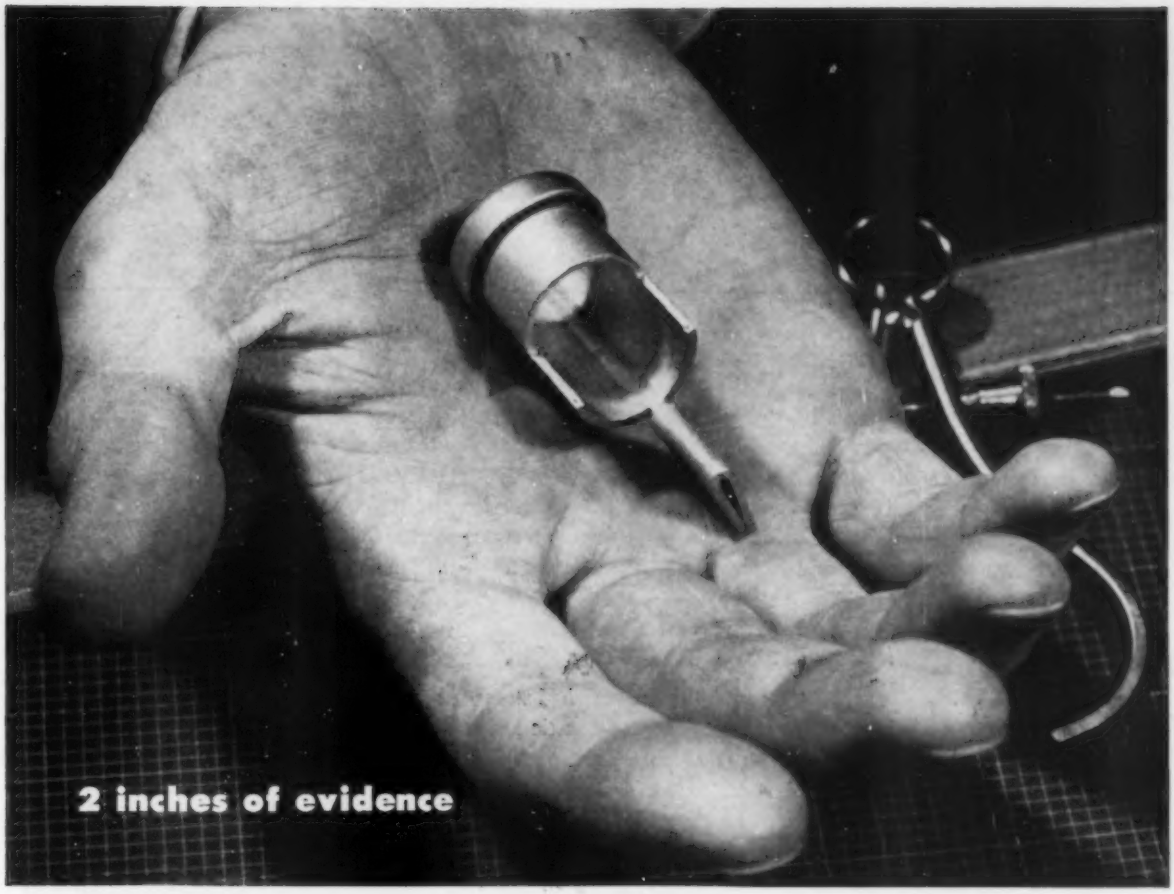
ALLEN-BRADLEY STARTERS FOR LARGE SYNCHRONOUS MOTORS

Bulletin No.	Type or Style	Manual or Automatic	Control	Starter Equipment	Maximum Horsepower at Rated Voltage 220V	440-550V	2000-2500V	2501-4600V
906	A	A	Across-the-line	Contactor	350	700	800	1500
906	C	A	" " "	"				
914		A	Reduced Voltage	Resistors	250	250		
922	AT	A	" "	Autotransformer	350	700	800	1500
922	CT	A	" "	"			800	1500
922	CR	A		Reactor				

8-54-R

Allen-Bradley Co.
1316 S. Second St., Milwaukee 4, Wis.

ALLEN-BRADLEY
TROUBLE FREE MOTOR CONTROLS
QUALITY



. . . that *Carpenter* Tubing Quality Helps Solve Design and Fabrication Problems

In the Carpenter mill a length of ⅝" I.D. tubing was selected at random. A 2¼" length was cut from one end. ¼" of this sample was then turned back upon itself. Properly spaced saw cuts were made at the other end of the sample and the defined area folded-bookwise with the tube weld at the point of the fold.

You can see the result pictured above. There are no cracks or splits at the rolled end. No trace of failure can be detected where the sample was folded at the weld.

What does this mean to you?

It means that if you are designing a part that can be bettered by the use of stainless tubing, Carpenter quality frees you from most design limitations.

It means, too, that if you are fabricating parts from stainless tubing, buying Carpenter is an easy way to insure trouble-free production even when severe working is required.

In short, there's a real difference in stainless tubing and Carpenter makes that difference. Why not examine the evidence yourself, in your own shop? Contact your Carpenter Distributor or nearest Carpenter Representative—he'll have one of these "reverse bend" samples to show you—can give you complete information on Carpenter Stainless Tubing and Pipe.

Here's information you can use. The new Carpenter Condensed Data File is packed with facts on corrosion resistance, weights, dimensions, forming and fabricating, analyses, etc. For your copy, write:

The Carpenter Steel Company, Alloy Tube Division, Union, N. J.
Export Dept.: The Carpenter Steel Co., Port Washington, N. Y.—"CARSTEELCO"

Carpenter

Stainless Tubing & Pipe

New Harvey aluminum alloy 66S will reduce your costs

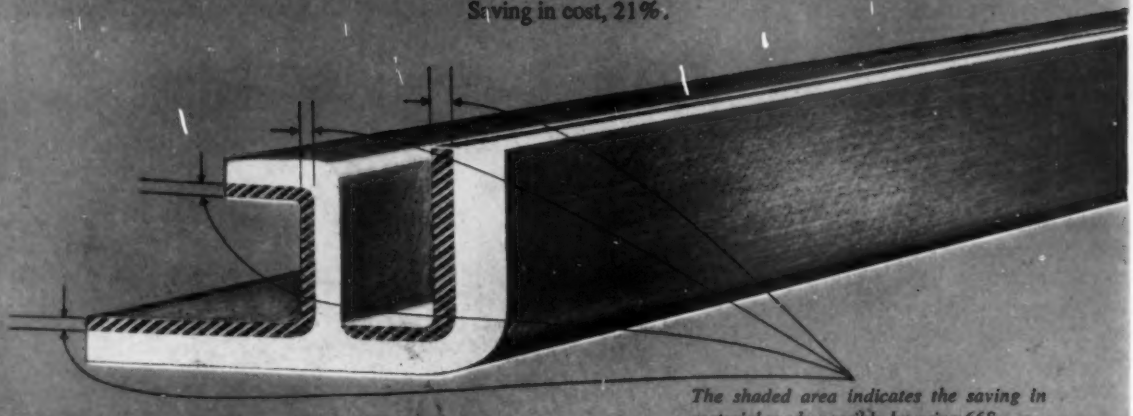
high-strength-low-cost-ratio

means that Harvey metallurgists have combined the essential qualities of many ideal structural alloys into a single new aluminum alloy—66S. This general purpose alloy is bringing real economy to many industries. It combines the high strength of 24S and the good corrosion resistance, weldability and economy of 61S.

Alert aluminum fabricators can now use 66S to reduce material costs, cut weight without sacrificing strength, and lower fabricating costs. You can reduce your costs at Harvey Aluminum . . . tooling service charges are nominal, and Harvey prepays the freight to your dock. Send for your Bulletin on 66S today.

here's how you save

The high yield strength of 66S permits you to reduce the cross section of structural members. This means real dollar savings in material costs. The extrusion below was made of 61S. By using the high yield strength of 66S its cross section is reduced as shown. The saving in material amounts to approximately 26%. Saving in cost, 21%.



The shaded area indicates the saving in material made possible by using 66S.

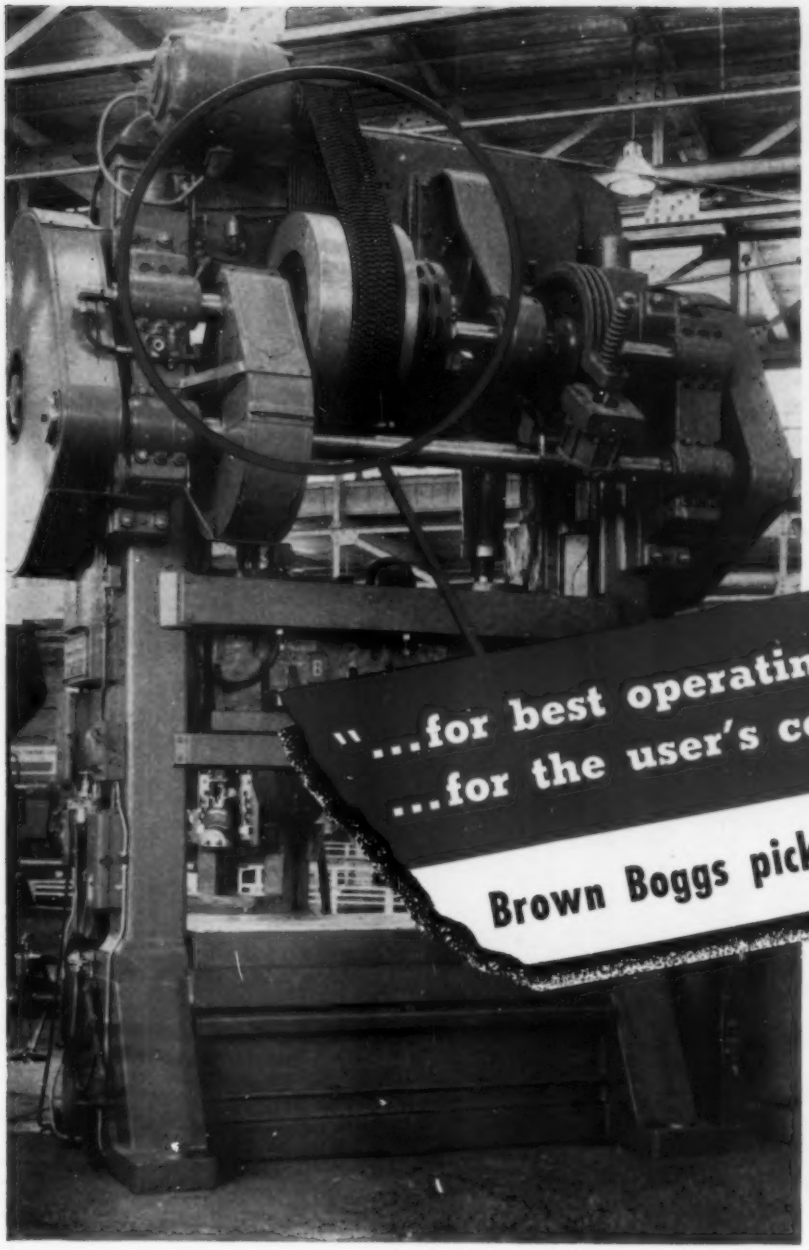
MAKING THE MOST OF ALUMINUM—FOR EVERYONE

HARVEY Aluminum

The men at Harvey Aluminum are dedicated to the idea of improving your product while reducing your costs. And remember, we prepay the freight to your plant.

HARVEY ALUMINUM SALES, INC.
TORRANCE—LOS ANGELES, CALIFORNIA
BRANCH OFFICES IN PRINCIPAL CITIES

An independent producer of aluminum extrusions in all alloys and all sizes; special extrusions, press forgings, bar stock, forging stock, tubes, impact extrusions, aluminum screw machine products and related products.



The Brown Boggs Foundry & Machine Company, Ltd., of Hamilton, Canada, who manufactures this 200-ton Press, thoroughly checked all types of v-belt. They wanted a v-belt that would give efficient, vibrationless, full power delivery. They wanted a v-belt that could be installed quickly and easily. Only Veelos met *both* requirements. And here's what Brown Boggs says about their selection of Veelos . . .

"...for best operating condition ...for the user's convenience"*

Brown Boggs picked Veelos v-belt

*"*We feel that our own factory assembly has put this Press in the best operating condition. To eliminate the necessity for dismantling any part of the equipment, and for the user's convenience in changing belts, we have equipped the drive with Veelos V-Belting.*"

Brown Boggs selected Veelos even though it cost more than ordinary v-belt. They know, however, that "what's best for their customer, is best for their business!" It will pay you to equip your machines with Veelos v-belt. Once you've done that you'll be an enthusiastic Veelos user, too.

Veelos is known as Veelink in Canada and foreign countries.

VEELOS
THE LINK
V-BELT

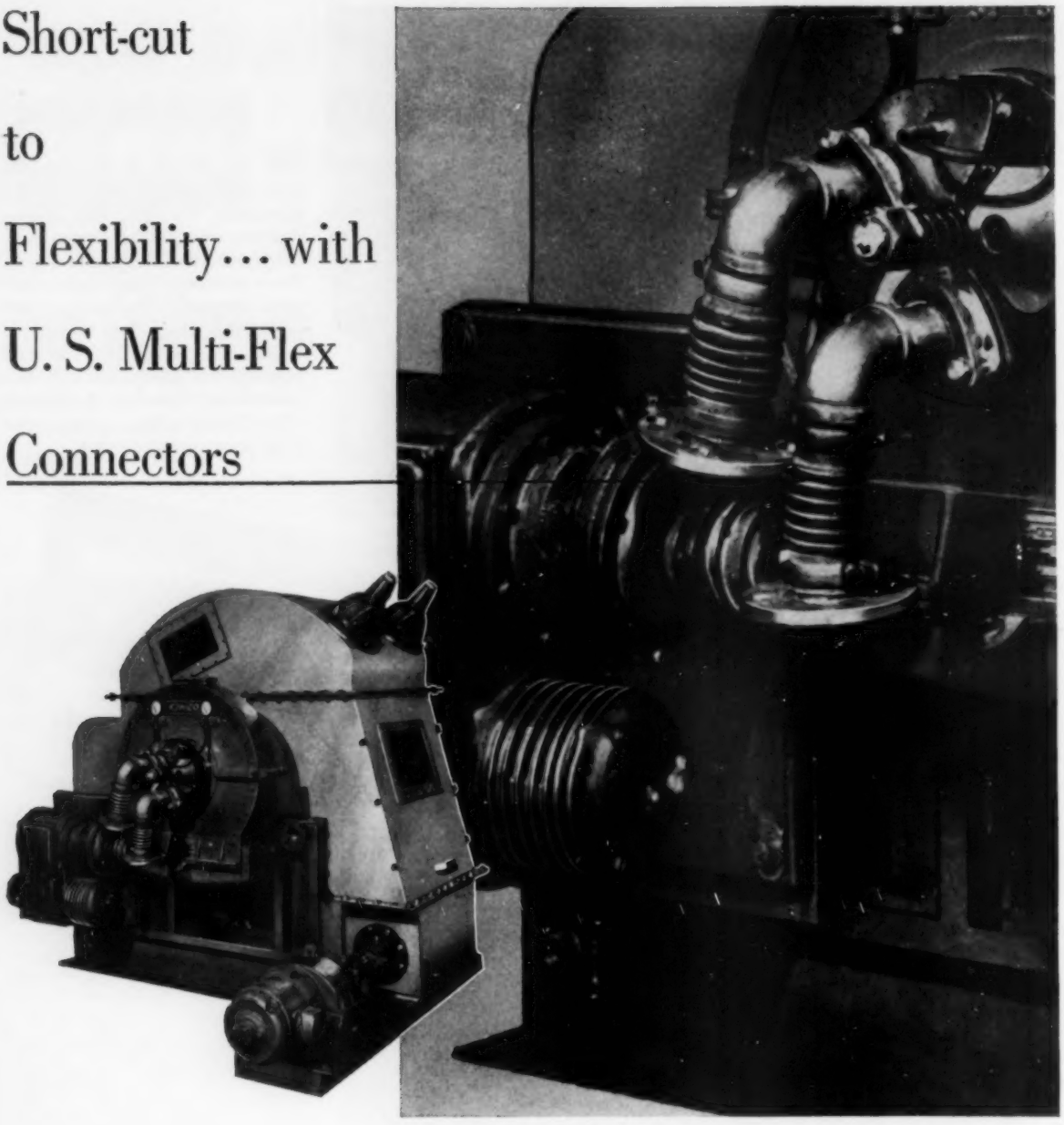
Get the full story on Veelos... write today for your free copy of the VEELOS DATA BOOK.

MANHEIM MANUFACTURING & BELTING COMPANY

610 Manbel Street, Manheim, Penna.

ADJUSTABLE TO ANY LENGTH • ADAPTABLE TO ANY DRIVE

Short-cut to Flexibility... with U. S. Multi-Flex Connectors



Now the equipment designer can turn out a more efficient, trouble-free product – with U. S. Multi-Flex® Connectors. Here's one example: The vacuum filter shown above uses these connectors to take care of axial movement caused by compression and extension *and* to allow for misalignment.

Developed by United States Rubber Company, Multi-Flex Connectors need no molds or specially-tooled mandrels. Multi-Flex Products are made of rubber, or rubber and fabric, in sizes from ¼" to 36" I. D.

Other Multi-Flex products fill a wide range of needs, including many which cannot be met by conventional means. Among these are air ducts, protective boots, connectors for conveying air or liquids, corrugated tubing and bellows for moving air.

For engineering advice, call on any of our 27 District Sales Offices or write to address below for a free copy of our Multi-Flex Catalog.

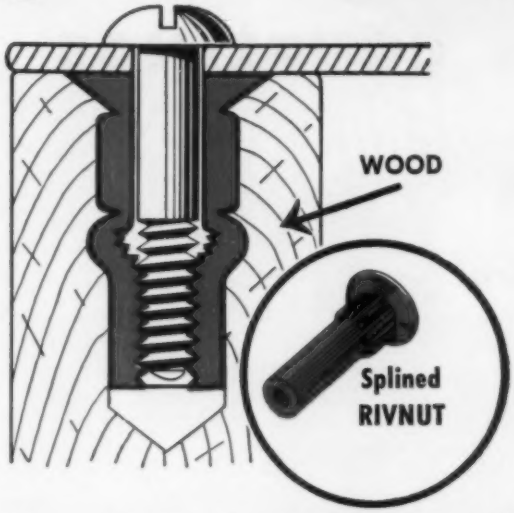
"U.S." Research perfects it...
"U.S." Production builds it...
U.S. Industry depends on it...

US RUBBER

UNITED STATES RUBBER COMPANY
MECHANICAL GOODS DIVISION · ROCKEFELLER CENTER, NEW YORK 20, N. Y.

Hose • Belting • Expansion Joints • Rubber-to-metal Products • Oil Field Specialties • Plastic Pipe and Fittings • Grinding Wheels • Packings • Tapes Molded and Extruded Rubber and Plastic Products • Protective Linings and Coatings • Conductive Rubber • Adhesives • Roll Coverings • Mats and Matting

B. F. Goodrich RIVNUT set in wood gives 6 clean threads for fastening

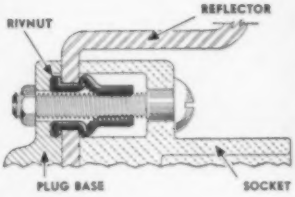


B. F. GOODRICH RIVNUTS eliminate use of wood screws where their frequent removal quickly wears away the wood. Imbedded and upset in wood, a BFG Rivnut provides at least six clean threads for screw attachment. Bulge formed by upsetting with easy-to-use heading tools holds Rivnut fast. Splined shaft or key in Rivnut head provides needed torque resistance.

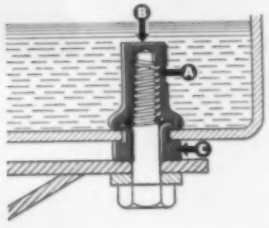
One manufacturer now uses splined Rivnuts to fasten the backs of television sets (see application at left). Screw holes in the cabinet were wearing too big from removal of wood screws.

The splined Rivnut is only one of many types of Rivnuts that solve tough fastening problems in wood, metal, plastic, many other materials. Rivnuts can be installed by *one* man from *one* side of the work in *two* seconds. They can be installed after enameling without marring finish. They save time, cut production costs, make products better. Consult a Rivnut engineer for help with *your* fastening problem. For complete information, write The B. F. Goodrich Company, Dept. PE-94, Akron, Ohio.

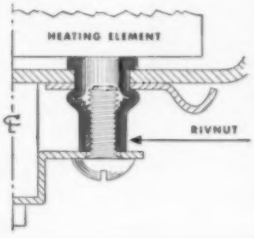
If you have fastening jobs like these, get B. F. Goodrich RIVNUTS



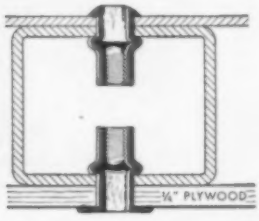
1. DOES 2 FASTENING JOBS! B. F. Goodrich Rivnuts fasten spotlight socket to reflector; same screws hold plug base to reflector. Former method demanded piercing, tapping, welding operations.



3. ELIMINATES BRAZING! Rivnuts with closed end (B) are installed in one-tenth the time it took to braze nut plates on oil reservoir tanks. Leaking, warping and thread cleaning are eliminated (A). Spacer head (C) positions tank.



2. ELIMINATES REINFORCING PLATE! In assembly of vaporizers, Rivnuts do away with reinforcing plate, don't turn under torque, hold flange securely without bending. Result: less assembly time, fewer parts, better product.



4. FASTENS PLYWOOD TO STEEL! Easier to install than wood or self-tapping screws, Rivnuts fasten plywood walls to tubular steel sections in trailers. No wood filler needed.

B.F.Goodrich

RIVNUTS

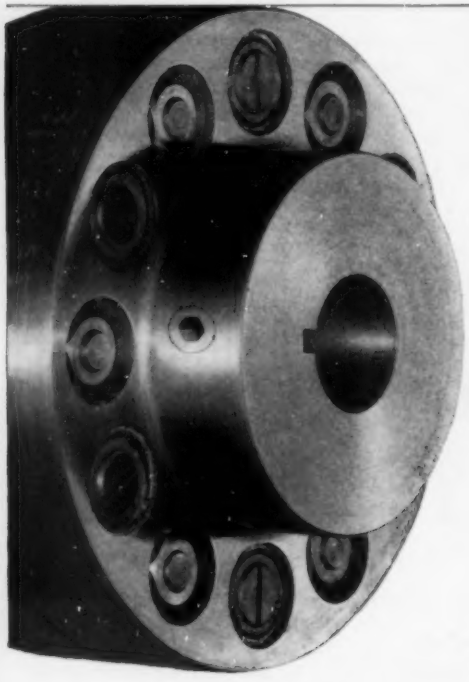
The only one-piece blind rivet with threads

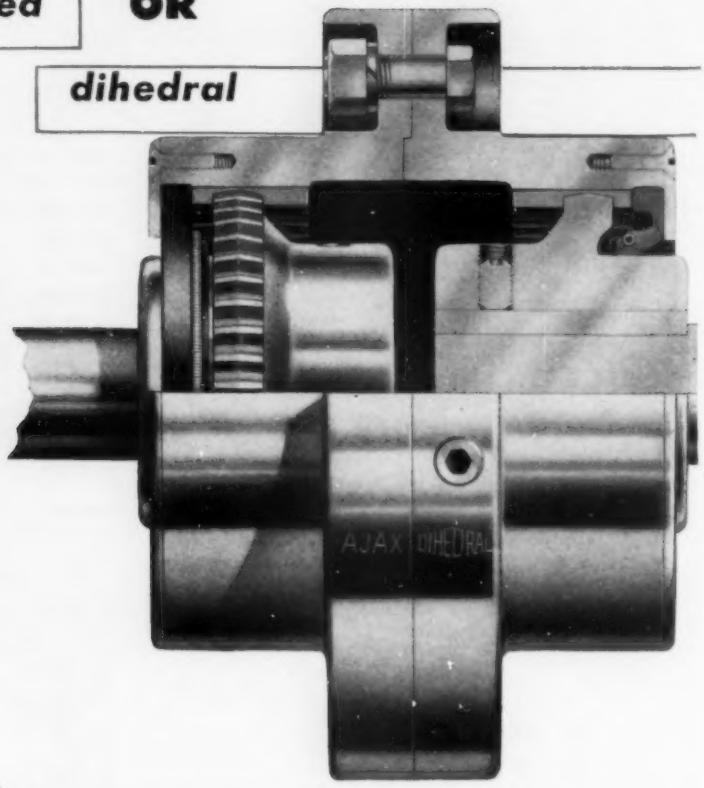
SEND NOW FOR FREE RIVNUT DEMONSTRATOR

Demonstrates with motion how you can use Rivnuts to fasten TO *and* fasten WITH. Explains construction, gives proved applications . . . Write for your free copy today to The B. F. Goodrich Company, Department PE-94, Akron, Ohio.

Specify AJAX FLEXIBLE COUPLINGS

rubber-bronze bushed **OR** **dihedral**





● Whenever you buy compressors, generators, pumps, conveyors, speed reducers or any other type of direct-connected equipment, it will pay you to specify Ajax Flexible Couplings.

Made in Rubber-Bronze Bushed and Dihedral gear types, they pay for themselves over and over again by protecting bearings, armatures and other costly parts against unavoidable misalignment. Installation and maintenance costs cut.

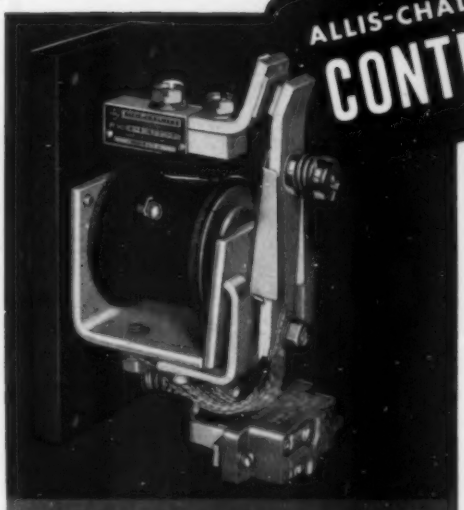
Ajax knows couplings. Write for latest bulletins.

AJAX FLEXIBLE COUPLING CO. INC. • WESTFIELD, N. Y.

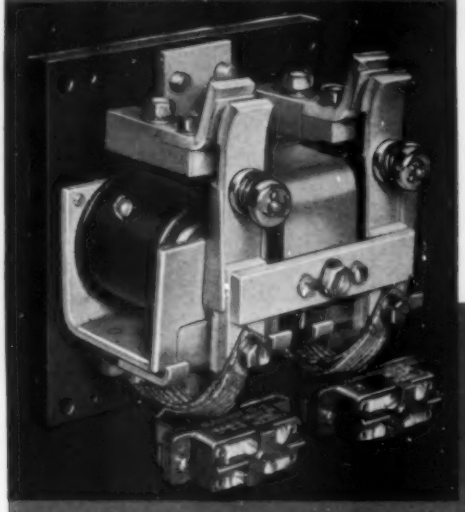
Representatives in Principal Cities

Recently developed
DC CONTACTORS
perform wide range of control functions

ALLIS-CHALMERS CONTROL



Type 264 single-pole general-duty contactor



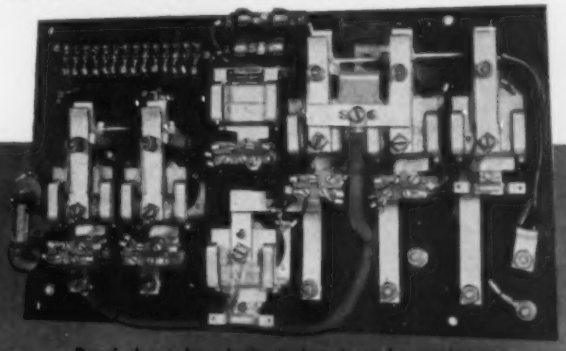
Type 264 reversing general-duty contactor

Acceleration, reversing, timing, plugging, switching. Allis-Chalmers Type 264 can be used singly for any of these tasks. Group-mounted, they perform several or all of these functions. This versatility, coupled with a compact design, provides equipment manufacturers with a new measure of control flexibility. Performance-proved on electric industrial trucks, cranes and hoists, these dc contactors may be applied wherever dependable intermittent duty is essential . . . wherever installation space is at a premium. Type 264 contactors are rated 200 and 400 amps at 36 volts.

Check these advantages

Compactness has been achieved without sacrificing accessibility. All normal wearing parts can be removed from the front.

Other features . . . Silver plated current-carrying parts. Silver alloy contact tips. Extra flexible stranded shunts. Amply sized single-break contacts. Optional interlocks.



A-4400

Panel shows how both single-pole and reversing contactors may be mounted to perform several functions.

How to Be Sure You Get the Right Controls for Your Product

Type 264 contactors are typical of the standard, modified standard and special controls designed and produced by Allis-Chalmers.

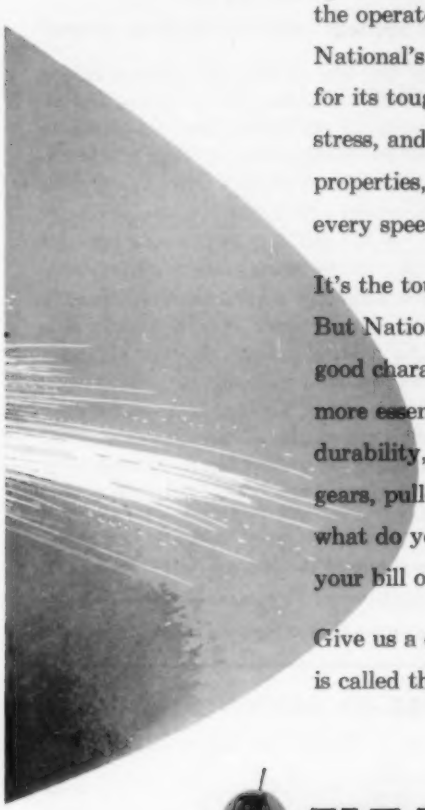
When your products reach the drafting board stage, call in your A-C representative. He'll be glad to give you comprehensive engineering assistance. Backed by the Allis-Chalmers engineering, research and testing facilities, he's fully qualified to make suggestions which may help you get substantial savings in time, money and trouble.

For details, call your District Office or write Allis-Chalmers, Milwaukee 1, Wis.

ALLIS-CHALMERS

NOTHING TAKES THE PLACE OF VULCANIZED FIBRE

the tough stuff that makes a rough job easy to handle . . .



Sanding and grinding work is most likely to smooth out successfully for the operator when he uses abrasive discs made of vulcanized fibre. National's Abrasive Fibre is favored among the makers of abrasive discs for its toughness, high tear strength, ability to withstand severe mechanical stress, and for the long service it provides. It has outstanding gluing properties, too. The overall result is performance that pays off at every speeding turn of the wheel.

It's the toughness of our fibre that counts in abrasive discs. But National Vulcanized Fibre is so versatile—so inherently endowed with good characteristics—that this material offers practically every industry one or more essential qualities. Light weight, high dielectric strength, resilience, durability, machinability—what does *your* business *need?* Electrical components, gears, pulleys, bobbin heads, welders' masks, football helmet crowns—what do you *make?* National Vulcanized Fibre is almost certain to fill your bill of specifications, no matter how exacting.

Give us a call. We'll be glad to show you why National Vulcanized Fibre is called the Material of a Million Uses.

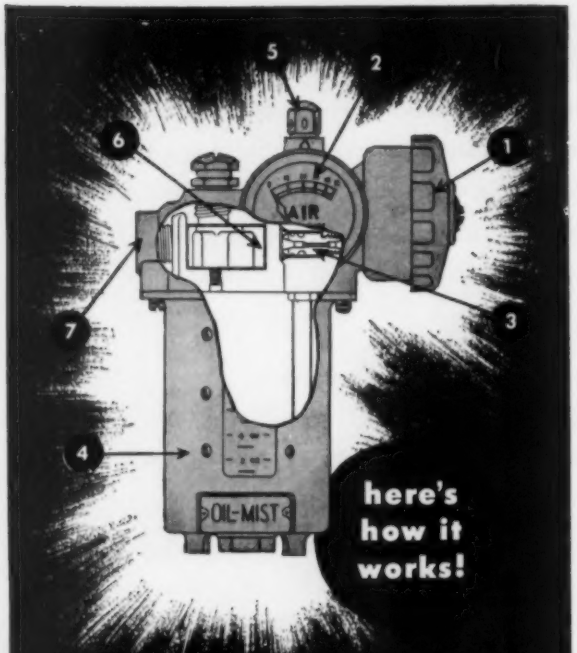
NATIONAL
VULCANIZED FIBRE CO.
WILMINGTON 99, DELAWARE

FOR YOUR STAFF—*just off press . . . an eight-page booklet entitled "Meet 'Sherlock' Fibre (or, Clues You Should Know To Make Profits Grow)." Tells—at a minimum of your reading time—why National Vulcanized Fibre is "the material of a million uses." Ask the National representative nearest you for your copy. He's listed in the classified directory. Or write to National Vulcanized Fibre Co., Dept. B-9, Wilmington 99, Delaware.*

Also manufacturers of Phenolite Laminated Plastic, Vul-Cot Waste Baskets, Peerless Insulation, Materials Handling Equipment, and Textile Bobbins.

Designers told us what they needed—what industry had to have!

ALEMITE OIL-MIST



This Oil-Mist Lubricator atomizes oil into microscopic particles which are carried in the air stream and distributed through tubing to the bearings. Compressed air enters and passes through the air regulator (1) and air gauge (2). As this air passes through venturi (3) it draws oil from the reservoir (4). Oil flow is set by knob (5). The mixture of oil and air from the venturi is thrust against the baffle (6). Only the most minute, lighter-than-air particles are blown through the outlet (7) into the delivery line to bearings.

Proved in countless applications . . . MULTIPLIES Bearing Life . . . SLASHES Product Spoilage—BOOSTS Machine Output!

Case history after case history tells the record-breaking story of Alemite Oil-Mist efficiency. This amazing lubrication system has actually multiplied bearing life up to twenty times! Has eliminated product spoilage and housekeeping problems encountered with other lubricating methods! Has increased production on machine after machine! Yet the cost of Oil-Mist is surprisingly low—far less than the cost of even one major bearing failure!

This completely new concept in lubrication is extremely simple. Easy to incorporate into new designs—equally easy to use in modifying existing designs. Oil-Mist applies a constant, clean, cool film of oil uniformly to working parts—groups of bearings, slides, chains, gears—wherever needed. And in the form needed—liquid, spray or mist. Replaces grease systems. Lubricator has no moving parts—operates on compressed air, is completely automatic, completely foolproof!

A complete range of models and multiple unit models, in capacities of 12 ounces and one gallon, assure you a perfect choice for any application!

THREE TYPES OF BEARING FITTINGS

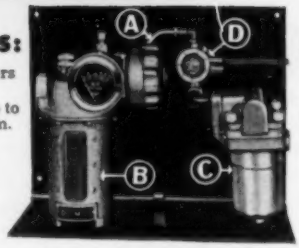
allow the use of Oil-Mist on any machine!

Oil-Mist Fittings bring the most efficient lubrication in the world to any anti-friction bearing—roller, needle or ball.

Spray Fittings are recommended for open and enclosed gears and chains. Allow for a concentrated spray of oil where it is needed.

Condensing Fittings apply oil in liquid form to plain bearings, slides, ways, vees, cams and rollers.

LUBRICATOR SPECIFICATIONS:



- Oil-Mist outlet ½" fem. p.t. Air gauge registers to 50 psi. Operating air pressure—5 to 20 psi.
- Air regulator (A) reduces from pressures up to 200 psi. Normal air consumption—.7 to 1.2 cfm.
- Range of oils handled—to 1,000 sec. (S.U.V.) @ 100°F.
- Oil reservoir (B) capacity 12 oz. (approximately 1 week supply). Intake filter screen—70 mesh. Fill plug—9/16".
- Material—die cast aluminum body with nylon plastic window.
- Baffle-type water separator (C)—automatic self-dumping. Requires no manual attention—no filter elements to replace. Air inlet ¼" fem. p.t.
- Solenoid Control (D) starts system automatically when machine starts—foolproof.

Alemite Oil-Mist offers these lubrication advantages

Automatic Lubrication • Continuous Lubrication

Eliminates Guesswork • Greater Safety • Cuts Oil Consumption up to 90% • Extension of Bearing Life • Stops Oil Drippage

Reduction of Bearing Temperatures • Manpower Savings

Elimination of "Down-Time" • Reduction in Number of Lubricants • Protection from Contamination

Alemite OIL-MIST Lubrication

A PRODUCT OF SW STEWART WARNER

Write Today! This Oil-Mist Catalog and Engineering Data Book is FREE for the asking. Write now for your copy. Alemite, Dept. T-94, 1850 Diversey Parkway, Chicago 14, Illinois.

You can simplify purchasing . . . improve design . . . speed production

with improved C-D-F DILECTO® laminates

Only C-D-F, the Continental-Diamond Fibre Company, makes Dilecto laminated plastic, just as only Cadillac makes a Cadillac. Dilecto is 50 different materials with more combinations and variations in desired properties than we can tell you here.

But Dilecto has three important qualities that you should think about if you buy, design, or machine laminated plastics.

DILECTO HAS HIGH MECHANICAL STRENGTH

Mechanical strength is frequently an important determining factor in the selection of an insulating material. Insulating parts used in large electrical power equipment are frequently bulky. The high mechanical strength of Dilecto helps reduce size-dimensions of insulating parts without danger of failure. Instruments, meters and small motors frequently require very small insulating parts which must withstand comparatively large mechanical stresses. Insulation for use in high frequency circuits should have a minimum bulk factor for minimum dielectric losses. Dilecto fulfills these requirements with a combination of high mechanical strength and low loss factor, characteristic of the better C-D-F electrical grades.

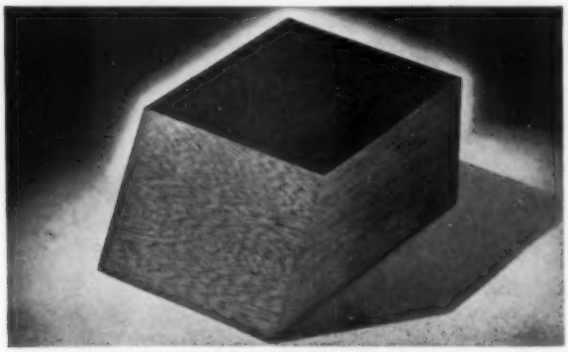
So C-D-F selects for your Dilecto insulation grade the correct, highest quality base material, paper, cotton, nylon, glass. These are used in combination with improved penetrating resins: Improved Phenolic, New Melamine, New Silicone, New Teflon, all synthetic, well polymerized resins.

Both the base and the resin are good insulators by themselves. But C-D-F sells them to you in an improved, practical form . . . Dilecto. Uniform sheets, tight tubes, strong rods, close tolerance machined and formed specialties, high bond strength metal clads.

Why does Dilecto combine so well mechanical strength with dielectric strength and dimensional stability? Because Dilecto is almost homogeneous, a true blend of resin and base.

DILECTO IS ALMOST HOMOGENEOUS

A poor laminate absorbs moisture at its edges, loses its insulating properties fast. Entrapped moisture and other volatiles within the cured structure causes inconsistent dielectric strength, with ultimate puncture and breakdown.



Punch press and bench saw operators know how much time and material is saved when the laminated plastic is *uniform* and *homogeneous* in nature like Dilecto.

DILECTO IS IMPROVED

Yes, C-D-F Dilecto is an improved laminated plastic, due to high standards and advances in resin and manufacturing techniques. It is watched by skilled workers in our modern plants, checked against rigid standards . . . C-D-F standards . . . by our quality control people. It is easy to machine, and the C-D-F shops are doing a booming business in specialties.

Table I—Typical Improved Phenolic Laminates

Commercial designation[a]	Resin	Filler	Improved properties	Improvement due to:
MEC-5	Phenolic	Nylon fabric	Insulation resistance; moisture resistance	Filler
XXHV-2[b]	Phenolic	Paper	High dielectric strength parallel to laminations	Resin and manufacturing technique
CRD	Phenolic	Cotton mat	Better machining	Filler
XXXP-26[b]	Phenolic	Paper	Insulation resistance; moisture resistance	Resin and manufacturing technique
C-92	Xylenol[c]	Cotton fabric	Alkali resistance	Resin
CF	Modified phenolic	Cotton fabric	Postforming	Resin

[a] All grades are Continental-Diamond Fibre Company.
[b] Resins have improved penetrating properties and the manufacturing techniques use these properties to provide better impregnation of the filler. Since thorough impregnation eliminates entrapped moisture and air, greater moisture resistance and better dielectric properties are attained. Manufacturing techniques also provide suitable temperature control during the curing stage to assure uniform quality and optimum property values in the finished laminate.
[c] Xylenol is essentially a dimethyl phenol.

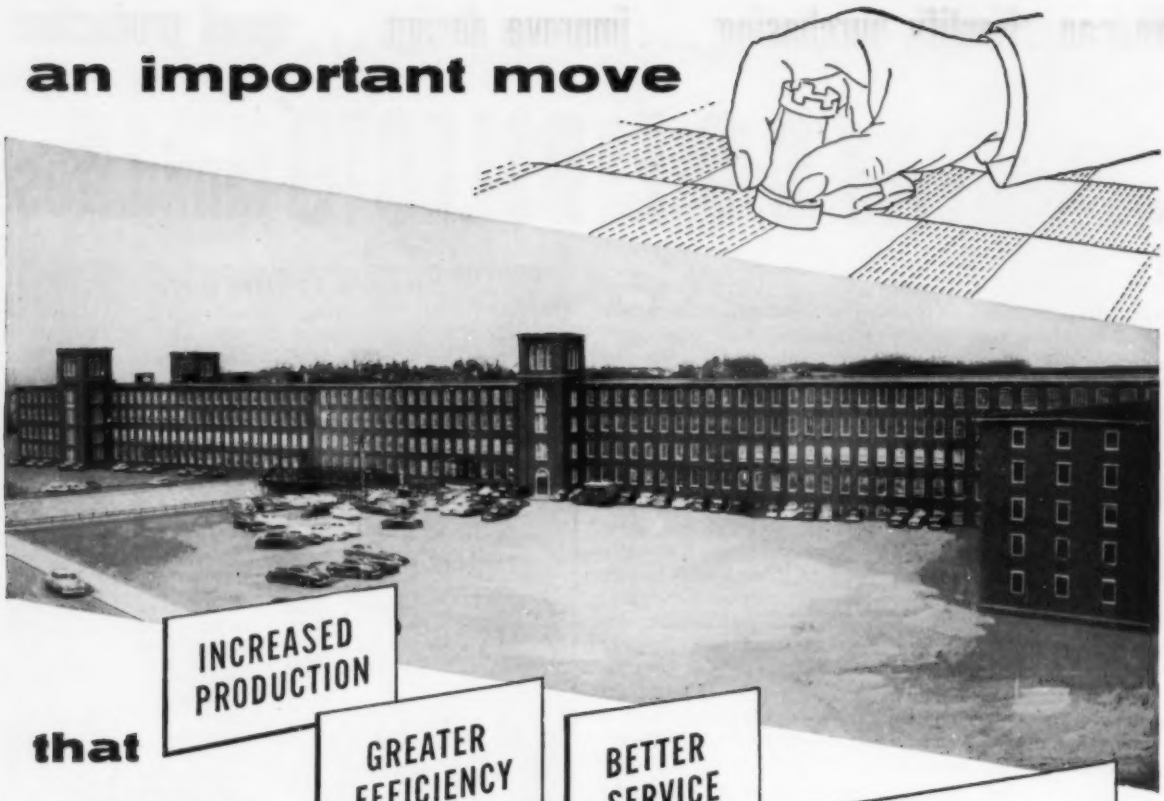
—from Electrical Manufacturing Article "Wider Design Opportunities with the NEW Phenolics", Part II.

The next time you think of laminated plastics, the name to remember is C-D-F Dilecto. The improved, high strength, uniform material that makes insulation buying and using more a science, less a puzzle. New grades, new applications, new savings are just part of the Dilecto success story. Look up the facts in Sweet's Design File, or write for catalog. Send us your blueprint for quotation . . . tell us your design dream . . . C-D-F wants to work with you.

C-D-F Continental-Diamond Fibre

CONTINENTAL-DIAMOND FIBRE COMPANY
NEWARK 40, DELAWARE

an important move



that INCREASED PRODUCTION means – GREATER EFFICIENCY BETTER SERVICE FOR EAD CUSTOMERS

Until recently, EAD's expansion was the acquisition of more and more small plants clustered about our main building in Brooklyn. Sooner or later something permanently suitable to our growing needs had to be found . . . and our new plant, in Dover, New Hampshire, is it. Now, under one tremendous roof — with more than 130,000 square feet of working space occupied, and additional space available for future needs — EAD has the elbow room to offer you better service than ever on all your motor and blower requirements. In looking forward to still greater expansion, we recognize the source of our progress — you, our customers and friends — and we shall strive to keep your friendship through constant development of newer and better rotating electrical equipment.

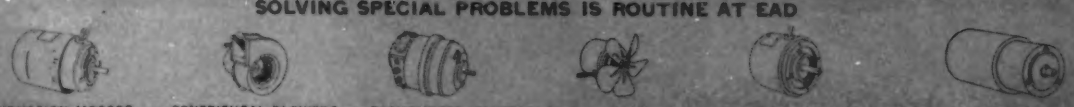
Solving Special Problems Is Routine at EAD

If your problem involves small rotating electrical equipment, bring it to EAD. Our completely staffed organization will modify one of our standard units or design and produce a special unit to meet your most exacting requirements.

EAD

EASTERN AIR DEVICES, INC.

SOLVING SPECIAL PROBLEMS IS ROUTINE AT EAD



INDUCTION MOTORS | CENTRIFUGAL BLOWERS | TACHOMETER GENERATORS | FANS | ALTERNATORS | GEAR MOTORS

381 CENTRAL AVENUE—DOVER, NEW HAMPSHIRE

"Take this man I'm going to see"

"Hi, Ed. Shining up for a date?"

"Sure enough, Jim. An important one, too. I'm calling on a new prospect. He's going into a new product and I'm sure he can use our fabrication facilities!"

"I thought you fellows at Wolverine only made tubing. I didn't know that you were set up to fabricate. Never thought of you as that type of source!"

"Fabrication is one of the things we specialize in, Jim. We're equipped to do just about anything to make a tubular part. Take this man I'm going to see, for example. This part he's making starts out as a sheet of copper. The way he has it figured out, it's going to take about eight separate operations to complete the part."

"But with Wolverine's Spun End Process* we can start out with a length of copper tube and in one operation we'll end up with the complete part. We do it by spinning the tube in special dies and the die gives it the desired shape. It'll give him a one-piece part—cut his costs in half."

"Say that sounds terrific. Our engineering department will be all ears when I tell them about this. I'm sure this spinning deal can help us, too."

"That's only part of it, Jim. We also do special bending, coiling, flaring, expanding, finning, swaging, piercing and drilling as well as soldering, brazing and threading. Add to this the fact that besides copper, we work in copper-base alloys, aluminum and electric-welded steel and you have a quick run-down of Wolverine's fabricating facilities."

ALL-IN-ALL IT ADDS UP TO TUBEMANSHIP. That's Wolverine's word for the type of thinking that combines tube manufacturing with fabrication. You'll find the complete story as well as a host of new ideas in Wolverine's Fabricated Parts Book. Write for your copy today. WOLVERINE TUBE, Division of Calumet & Hecla, Inc., 1479 Central Avenue, Detroit 9, Michigan.

*PATENTED PROCESS RE. 22465

WOLVERINE TUBE
DIVISION OF CALUMET & HECLA, INC.
Manufacturers of Quality-Controlled Tubing

PLANTS IN DETROIT, MICHIGAN, AND DECATUR, ALABAMA. SALES OFFICES IN PRINCIPAL CITIES.

EXPORT DEPARTMENT, 13 EAST 40TH STREET, NEW YORK 16, N. Y.

How papers by Mosinee make products safer, more efficient

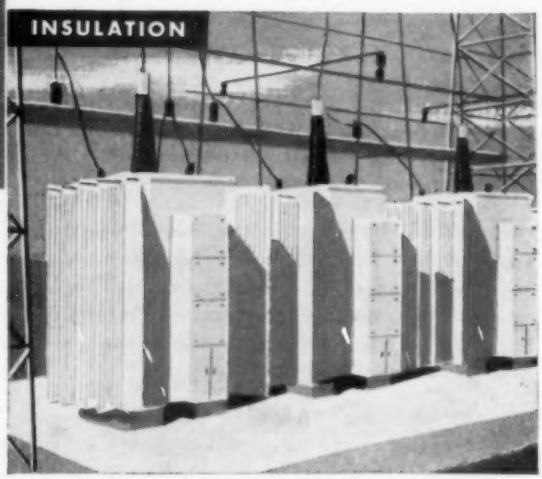
From cooling rooms to heating homes or guarding electrical apparatus – Mosinee specially developed papers help do the job better.

IN these and hundreds of other cases involving insulation, fabrication, lamination, processing or packaging — Mosinee papers play an important part in getting optimum results with minimum trouble and expense.

It will pay you to find out how Mosinee experts cooperate with industry to develop specialized papers. Current applications of Mosinee papers will suggest immediate ways in which you can make substantial savings in time and money. Write today for complete information.

Evaporative cooler pads for room coolers are made from Mosinee controlled paper. A high rate of moisture absorption with wet strength are two of the critical properties of this highly specialized paper. In addition, this paper must be adapted to easy slitting and expanding in the conversion operation for pad construction. Here's typical Mosinee precision control at work.

Mosinee flame-resistant papers increase safety factor of filters employed in warm air heating systems. The process of making these papers flame-resistant was developed by Mosinee technicians. This process, applicable to many types of paper, may help you solve a product or processing problem.



Special analysis Mosinee papers improve performance of electrical components. These electrical insulation papers must be closely controlled to provide a low ash and chloride content. They are used extensively as layer insulation between turns of field coils and in transformers — from the smallest to one of world's largest. Ask about Mosinee papers for your electrical requirements.

MOSINEE PAPER MILLS COMPANY
DEPT. PE • MOSINEE, WISCONSIN

Mosinee

Specialists in industrial paper technology — makes fibers work for industry.

Users praise Phillips Cross-Recessed-Head Screws

REPUBLIC AVIATION finds the speedy, tight fastening of recessed head screws invaluable. On access plates, for instance, through which the plane is serviced and repaired, such screws are essential. Servicing of components is done many times and easier if such screws are used on access covers. Raymond Whalen fastens wing tip covering foreground, while B. Broman installs access plates using Phillips type recessed head screws.

PRODUCTION IS SPEEDED ON CALDWELL WINDOW SASH BALANCES due to Phillips screws. "Our power drivers are mounted horizontally," points out Kenneth Meyers, production manager, "and, before using Phillips screws, fast operators found it hard to engage screws immediately. Valuable time was wasted while the driver spun around uselessly. With Phillips screws, the screw assembly is now the quickest operation in the entire production schedule." Raymond Beecher here assembles the outer case of a Caldwell Sash Balance.

APEX WASHING MACHINES are designed for a minimum of 20 years service. "One reason our machines have such a long life," states William A. Haverlock, superintendent of assembly, "is the highly protective coating offered by the enameled finish. By using Phillips screws, we have eliminated the danger of scratching this finish. This results in considerable saving in refinishing — and eliminates production headaches caused by interruption of assembly line."

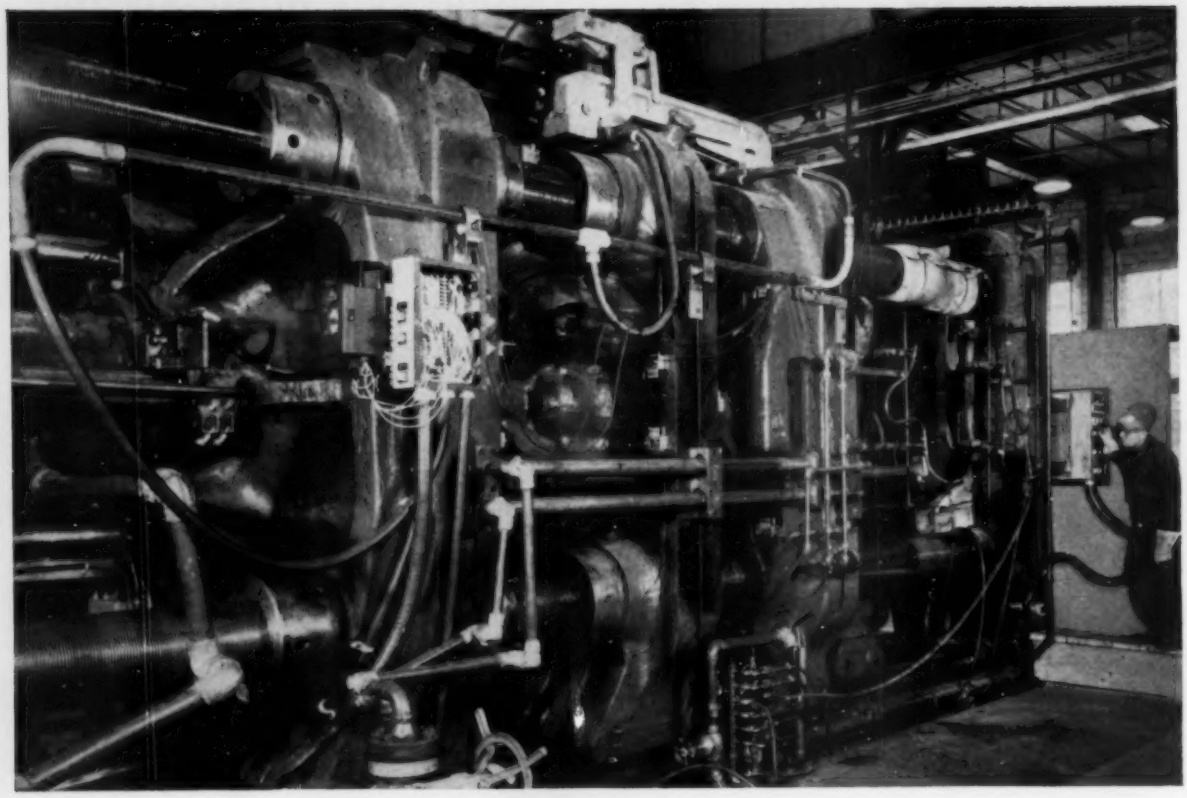
• MANUFACTURERS OF • PHILLIPS CROSS-RECESSED-HEAD SCREWS

THE FASTENERS OF TODAY... AND OF THE FUTURE

X marks the spot

... the mark of extra quality

American Screw Company • Atlantic Screw Works, Inc. • The Blake & Johnson Co. • Central Screw Company • Continental Screw Company • The Eagle Lock Company Elco Tool and Screw Corporation • Great Lakes Screw Corporation • The H. M. Harper Co. • The Lamson & Sessions Company • National Lock Company • The National Screw & Manufacturing Co. • Parker-Kalon Div. General American Transportation Corporation • Pheoll Manufacturing Co. • Rockford Screw Products Co. • Scovill Manufacturing Co. • Shakeproof • The Southington Hdwe. Mfg. Company • Sterling Bolt Company • Wales-Beech Corp.



The leader, Doehler-Jarvis, takes another step forward...a Giant 72-inch die casting

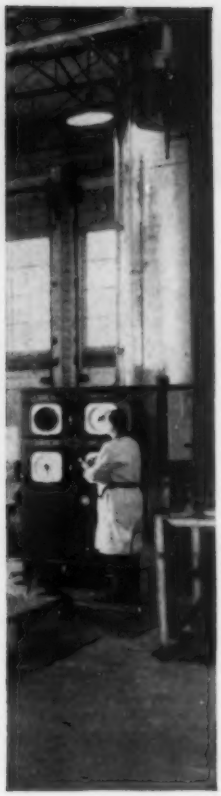
In one tremendous thrust Doehler-Jarvis has broken through the "size barrier" that limited pressure-cast metal components to comparatively small dimensions and light weights.

The new 250-ton machine recently put into operation by Doehler-Jarvis can produce aluminum castings weighing up to 75 lbs. and measuring practically anything that will go between the tie-bars. Adapted to zinc, it can handle shots up to 200 lbs.

Ever since the invention of the first practical pressure die casting machine about a half century ago, many people have felt that "Doehler and die casting" were synonymous. It's common knowledge that just about every "first" in this fast, efficient process of forming metal parts has been credited to the Doehler organization.

This new machine is, in a way, the culmination of fifty years of effort to widen the horizon for die cast components. And the effort will not stop here.

Why don't you put Doehler-Jarvis to work on your metal-parts problem?



Castings are removed from machine by mechanical "arms." Cable reel flanges shown here weigh 41 lbs. as they come from the die, and 31 lbs. after gate and flash are removed.

This huge machine "eats up" about a ton of aluminum per hour. An automatic ladle was developed to handle this large metal consumption.

Stride...with this machine

Doehler-Jarvis Division
of
National Lead Company
General Offices: Toledo 1, Ohio

*Reg. U.S. Pat. Off.

The die used in producing cable reel flanges weighs about 25 tons — much more than the complete die casting machine shown below. This early Doehler machine, by the way, still operates.

ONE OF A SERIES

You Get Many Benefits
by Specifying VICKERS® Hydraulics

Hydraulics School for Customers' Own Service and Maintenance Men

Manufacturers who have Vickers Hydraulic Equipment on their machines can have their own service men trained in the Vickers Hydraulics School. Since its beginning in 1945, this school has trained more than 800 men from approximately 400 companies. There is no tuition charge for this training course.

These men are given a thorough schooling in hydraulic theory and practice . . . and in the operation and maintenance of Vickers Hydraulic Equipment. The benefits to manufacturers of Vickers-equipped machines are obvious. Of equal importance are the benefits to users of such machines who are thus assured of better maintenance.

Again, this is only one of many reasons why it pays to specify Vickers Hydraulics.

VICKERS Incorporated
DIVISION OF THE SPERRY CORPORATION
1454 OAKMAN BLVD. • DETROIT 32, MICH.

Application Engineering Offices: ATLANTA • CHICAGO (Metropolitan) • CINCINNATI • CLEVELAND DETROIT • HOUSTON • LOS ANGELES (Metropolitan) NEW YORK (Metropolitan) • ODESSA • PHILADELPHIA (Metropolitan) • PITTSBURGH • ROCHESTER • ROCKFORD SEATTLE • TULSA • WASHINGTON • WORCESTER

6393

ENGINEERS AND BUILDERS OF OIL HYDRAULIC EQUIPMENT SINCE 1921

TIMKEN® seamless tubing eliminates drilling, saves steel and machining time!

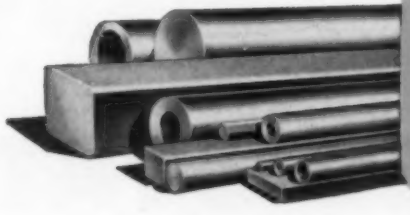
NO need to bore out bar stock to make hollow parts when you use Timken® seamless tubing. The center hole's already there! You don't waste steel but only pay for the steel you use.

Because you don't have to bore the center hole, you save machining costs, too. Finish boring is often your first production step. Screw machine stations can be released for other jobs. So you add machining capacity without adding machines.

Our engineers will save you even more money, too, by studying your problem and recommending the most economical tube size for your hollow parts jobs.

You're assured of the highest internal quality with Timken seamless tubing. The piercing process by which it's made is basically a forging process. It has a uniform spiral grain flow for greater strength, and a refined grain structure which brings out the best quality of the metal. And the Timken Company's rigid quality control keeps this quality uniform from tube to tube and heat to heat. The Timken Roller Bearing Company, Steel and Tube Division, Canton 6, Ohio. Cable address: "TIMROSCO".

YEARS AHEAD — THROUGH EXPERIENCE AND RESEARCH



TIMKEN
Fine Alloy
STEEL

SPECIALISTS IN FINE ALLOY STEELS, GRAPHITIC TOOL STEELS AND SEAMLESS TUBING

GRAPHITAR® HELPS HARNESS

THE POWER OF THE ATOM IN NEW ATOMIC SUBMARINE *NAUTILUS*

GRAPHITAR is a carbon-graphite engineering material that has proved successful in hundreds of difficult applications.

- **GRAPHITAR** can be formed in relatively complicated shapes and ground to tolerances as close as .0005".
- **GRAPHITAR** is lighter than magnesium and harder than most steels. It is mechanically strong and durable and highly resistant to wear.
- **GRAPHITAR** is practically unaffected by high speeds, high altitudes, high pressures or temperature extremes.

OUR 100th YEAR

THE UNITED STATES

The Westinghouse Electric Corporation, working closely with the Atomic Energy Commission, has designed and built the nuclear power plant for the first atomic-powered submarine, the Nautilus. In atomic power operations, where radioactivity is a difficult problem, fluid systems must usually be hermetically sealed because conventional pumps with external drive motors are not adaptable to this type of operation. For the submarine's power reactor, Westinghouse engineers developed special hermetically sealed pumps with integrated pump and drive motor. The bearings in these pumps, which are made of GRAPHITAR, must withstand high speeds, high temperatures, high pressures and must also operate for indefinite periods of time without maintenance with radioactive hot water as the only lubricant. All leakage past the pump seal is contained within the flooded motor while the purely electrical elements are contained in "cans" to exclude water.

When the Nautilus is put into service, the power to run its conventional steam turbine, which is the actual driving power for the submarine, will come from atomic fires in the reactor where controlled nuclear fission produces enormous amounts of heat. The heat is transferred to the boilers through a closed circuit where the boiler water is turned into steam which is used for driving the turbine. Continuous, trouble-free circulation is extremely vital in this system and it is here that GRAPHITAR is proving its ability to help harness the power of the atom for the future good of mankind.

195

GRAPHITE COMPANY

DIVISION OF THE WICKES CORPORATION, SAGINAW, MICHIGAN

BUILT-IN EFFICIENCY

Every Lamson fastener is designed to serve a particular application. For maximum efficiency, most economical assembly and most satisfactory appearance, choose the fastener that's "right for the job".

The fasteners shown here each have their place in your assembly line. Choosing the right fastener for the right job is one way to take advantage of their "built-in efficiency".

PHILLIPS HEAD

There are many reasons behind the design of the Lamson Phillips head. The "X" slot really clings to the driver bit for faster assembly. They are self-aligning and straight-driving, perfect for spiral or power drivers. They draw up tighter than a slotted head, without head loss or damage and they offer the best appearance on the finished job. These advantages are yours when you specify Lamson Phillips Head tapping screws and machine screws. Available in flat, round, oval, fillister, pan and truss head shapes.

SPIN LOCK

Lamson Spin Lock fasteners are designed to "bite" and hold. The ratchet-like structure of the teech prevents "backing off" when the fastener is set. This, obviously, makes for very high holding power. Five head styles: hex, pan, truss, flat and large flat. For tapping screws and machine screws that are vibration proof, easy driving, water and oil tight around the head and that tighten flush to surface, specify Lamson Spin Lock.

SEMS

These pre-assembled washer and screw units can really save you time. No fumbling for washers, no doubling of inventory and no special assembly techniques are just a few of the advantages. Sems are available with two washer types; toothed washers and helical spring washers, and a broad variety of screws. Head styles include flat, oval, truss, pan, round, fillister and hex.

CLUTCH HEAD

The straight-walled, shallow recess design of the clutch head offers real advantages in assembling procedures. The recess centers the driver. Because the slot is not tapered, any tendency for the driver to "climb out" is held to a minimum. This means greater safety and less driver pressure to draw up the fastener. The periphery of the head is unbroken, which means that you get a stronger screw, size for size, than any other type. In an emergency, Clutch heads can be serviced in the field with a common screw driver.

Complete information on these Lamson fasteners is yours for the asking

The LAMSON & SESSIONS Co.
1971 West 85th St. • Cleveland 2, Ohio
Plants at Cleveland and Kent, Ohio • Birmingham • Chicago

Lamson + Sessions

FOR PROMPT DELIVERY AND HELPFUL SERVICE, ORDER FROM YOUR LAMSON DISTRIBUTOR

PLUG NUTS
Ideal for blind or hard-to-reach places.

PIPE PLUGS
Forged steel, heat-treated.

"1035" SET SCREWS
Cup point type, hardened and heat-treated.

PLACE BOLTS
With "Built-in" spring action for positive locking.

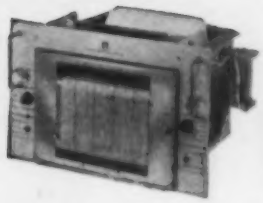
LOCK NUTS
Economical, vibration proof. Can be used repeatedly.

"BENT BOLTS"
Including U bolts, eye bolts, hook bolts, etc.

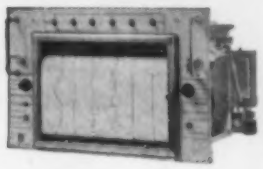
MACHINE SCREWS
Clutch and Phillips recessed head screws.

SEMS
Pre-assembled lockwashers on tapping and machine screws.

ONE DESIGN
MEETS MANY
REQUIREMENTS

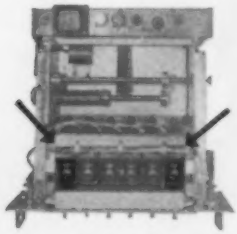


4
CHANNELS

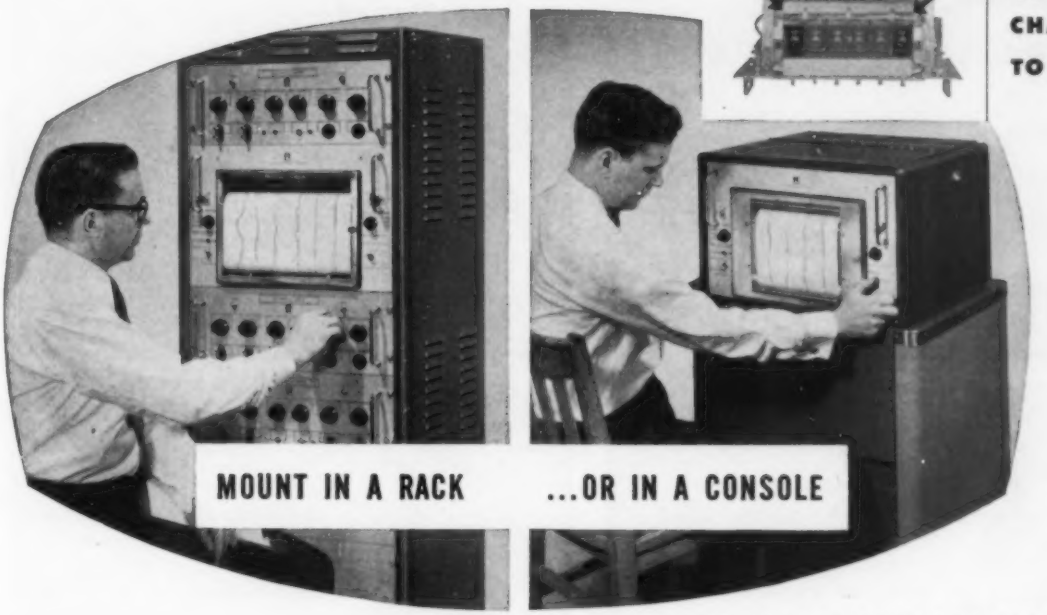


OR
6

NEW
BRUSH OSCILLOGRAPHS



OR
EXPAND
YOUR 4
CHANNELS
TO 6



Standardized design of these new Brush multi-channel oscillographs permits greater flexibility in instrumentation. An identical chassis which can be installed in either a standard 19-inch rack or a console is used for both 4 and 6-channel units. The new electrically-controlled chart drive provides up to sixteen speeds for greater flexibility of speed and operation. The chart can be driven as slow as 1 cm/hour or as fast as 250 mm/sec.—the highest chart speed available on any standard oscillograph. The units can be equipped for local or remote control. Get all the facts—send the coupon today, or call your Brush representative. Brush Electronics Company, Cleveland 14, Ohio. In Canada: A. C. Wickman, Ltd., Toronto.

BRUSH ELECTRONICS COMPANY
INDUSTRIAL AND RESEARCH INSTRUMENTS
PIEZO-ELECTRIC MATERIALS • ACOUSTIC DEVICES
MAGNETIC RECORDING EQUIPMENT
ULTRASONIC EQUIPMENT

formerly
The Brush Development Co.
Brush Electronics Company
is an operating unit of
Clevite Corporation.

Brush Electronics Company, Dept. L-9
3405 Perkins Avenue, Cleveland 14, Ohio

Gentlemen:

☐ Please send bulletin on new oscillographs.
☐ Please have your representative call.

Name _____

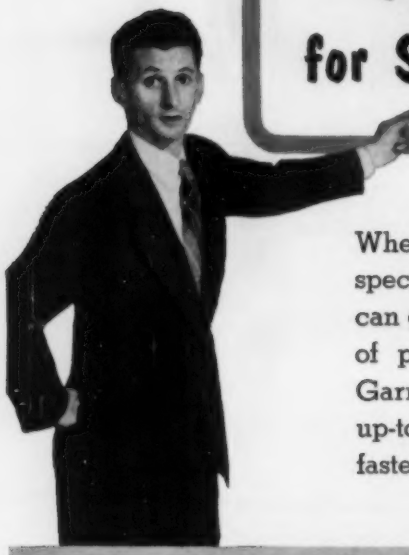
Position _____

Company _____

Address _____

City _____ *State* _____

YOU CAN'T BEAT GARRETT for SMALL PARTS and SERVICES

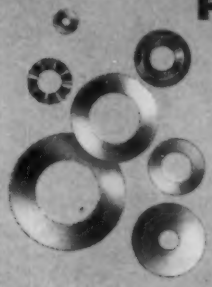


Whether they are small or medium size parts to regular specifications or special sizes and finishes . . . Garrett can give you quick deliveries. Garrett's stock of billions of parts make most deliveries possible from stock. Garrett's three modern plants equipped with the most up-to-date, precision automatic machines provide the fastest service on parts to your special specifications.

SPRING LOCK WASHERS

Complete line of high quality spring lock washers to ASA and SAE specifications, plus many special types . . . wide choice of metals plated to your requirements.

FLAT WASHERS



Fast delivery from the most complete line of washers in the world. Precision made in thousands of different sizes and types—all standard and many semi-standard sizes. Ready for delivery from stock to you.

HOSE CLAMPS

Aircraft AN 737 Stainless steel radial type. Multi-Clamp (QS100 & AN 748) worm type screw hose clamp. Auto-Seal, the inexpensive high quality hose clamp.

STAMPINGS

Quick deliveries on small and medium stampings made to your specifications on high-speed precision production presses. Finished, tumbled and plated to your specifications.

Write today for the Garrett catalog and technical data on these products.

MANUFACTURED BY

Garrett
OF PHILADELPHIA

GEORGE K. GARRETT COMPANY, INC. PHILA. 34, PA.

are easy to make in any size with

REINFORCED PLASTICS

Even unusual and irregular shapes are simple and economical to fabricate when you work with reinforced plastics made from glass fibers and BAKELITE Polyester Resins. The finished products have a high strength-weight ratio and superior resistance to impact. They can be pigmented with a variety of colors.

This carrying case is a good example. It's used for safe, convenient transit of the precision-built projector that forms an integral part of the "View-Master" 3-D system. With its deep, one-piece construction, it has no joints to come apart, and it won't lose its shape.

Large moldings like auto bodies and aircraft radar housings show the scale on which reinforced plastics made with glass fibers and BAKELITE Polyester, Epoxy, Phenolic, and Epoxy-Phenolic Resins can be used. These materials lend such outstanding properties as thermal, electrical, and chemical resistance to the products into which they are formed. Only Bakelite Company offers so many types of plastics with so many combinations of properties plus the largest research and development team in modern plastics. To learn more about these materials and their uses, write Dept. YU-10.

"Stereo-matic 500" projector carrying case manufactured by **Kimball Mfg. Corp.**, San Francisco 7, California, for Sawyers, Inc., Portland 7, Oregon.

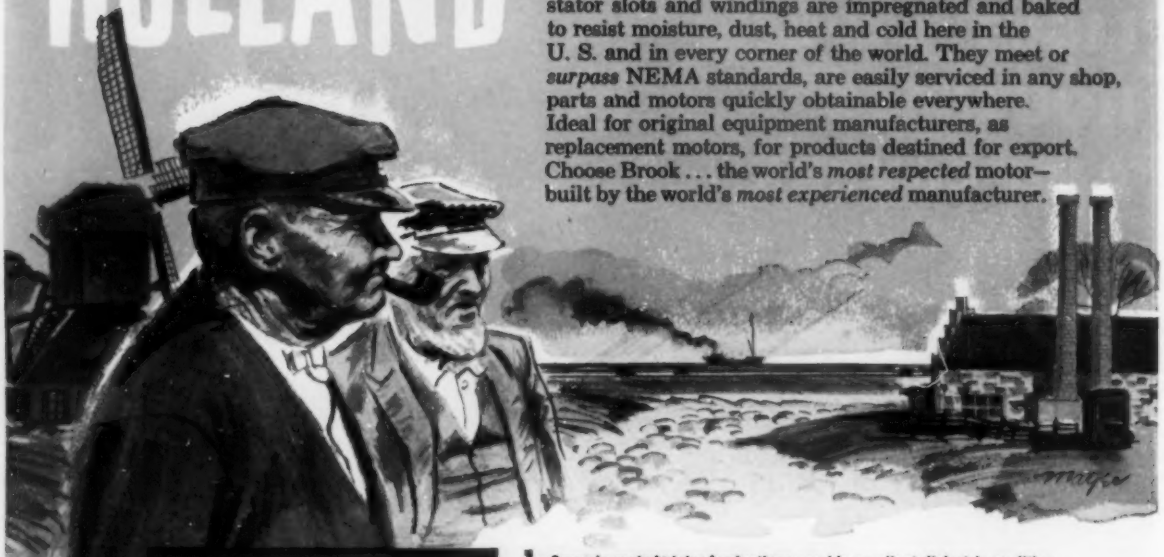
BAKELITE
TRADE-MARK
POLYESTER, PHENOLIC, AND EPOXY RESINS FOR REINFORCED PLASTICS

TRADE MARK

BAKELITE COMPANY
A Division of
Union Carbide and Carbon Corporation
UCC
30 East 42nd Street, New York 17, N.Y.

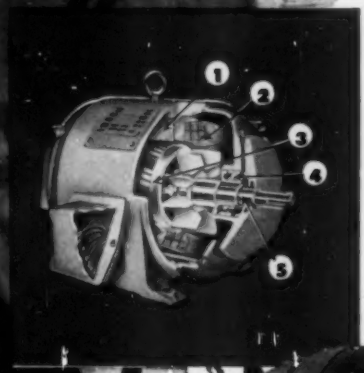
It turned back the tides of

HOLLAND



BROOK MOTORS ...can meet all your operating requirements, too!

It takes a quality motor of proven performance and dependability to stand up to the destructive forces of nature . . . it takes *Brook*, the world's *most respected* motor! Every Brook motor is built with the most precise care to give a lifetime of service . . . mica-insulated stator slots and windings are impregnated and baked to resist moisture, dust, heat and cold here in the U. S. and in every corner of the world. They meet or *surpass* NEMA standards, are easily serviced in any shop, parts and motors quickly obtainable everywhere. Ideal for original equipment manufacturers, as replacement motors, for products destined for export. Choose Brook . . . the world's *most respected* motor—built by the world's *most experienced* manufacturer.



1. **Ceramic-coated stator laminations** provide excellent dielectric qualities and maximum resistance to heat.
2. **Stator slots insulated with mica-coated fabric**—highly resistant to water, oil, heat and electrical strain.
3. **Dynamically-balanced rotors** to eliminate vibration . . . a practically indestructible unit of pure copper or aluminum passing through rotor laminations.
4. **U. S. standard interchangeable ball bearings** in metric sizes. Mountings protected against dirt and moisture.
5. **Precision-ground shaft**—painstakingly ground to the highest, most exacting standards. Made of the finest, high tensile steel.
6. **All major types**—available from stock . . . open drip-proof, splash-proof, totally enclosed non-ventilated, totally enclosed externally fan-cooled . . . in a wide range of horsepower sizes.

Get all the details about the complete Brook line . . . write today!

BROOK MOTOR CORPORATION
3555-57 W. Peterson Avenue, Chicago 45, Illinois

BROOK MOTOR CORPORATION

1904-1954
. . . . . respected and used the world over for 50 years!

The Tube Line That Rates a Buy-Line!

IN THE DESIGN and building of the products shown here, GM Steel Tubing plays an important part—either for the passage of liquids or gases, or as part of the mechanical structure. And these are but a few of the thousands of manufactured items that use low-cost steel tubing in place of more expensive materials. Examine your own requirements! You, too, may find you can *improve design, speed production,* and *cut costs* with "The Tube Line That Rates a Buy-Line"—GM Steel Tubing!

SEE SWEET'S PRODUCT DESIGN FILE 1a Ro

SEND FOR FREE BROCHURE

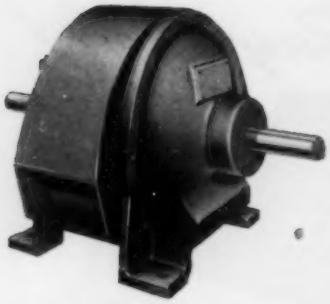
This new, illustrated, fact-packed brochure tells how GM Steel Tubing can help solve design and production problems. Send today for your free copy.

GM STEEL TUBING

ROCHESTER PRODUCTS

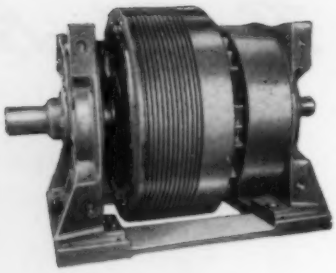
DIVISION OF GENERAL MOTORS, Rochester, N. Y., U.S.A.

ALSO MANUFACTURERS OF ROCHESTER CARBURETORS AND ROCHESTER CIGAR LIGHTERS

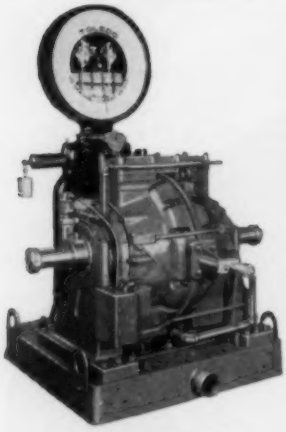


AIR COOLED COUPLINGS

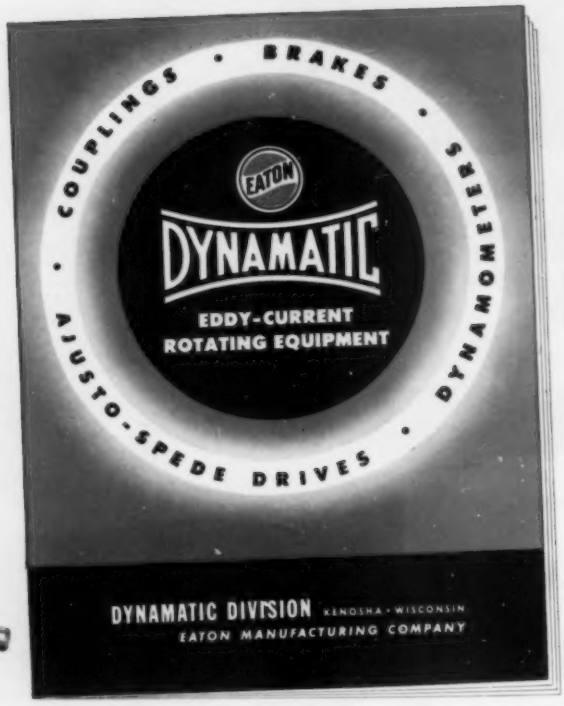
AJUSTO-SPEDE MOTORS

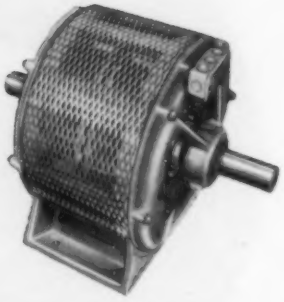


PRESS DRIVES

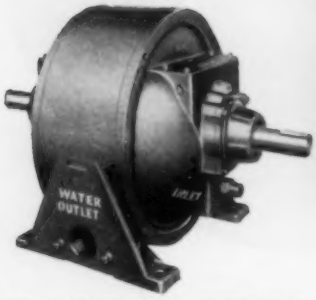


DYNAMOMETERS





AIR COOLED BRAKES



LIQUID COOLED COUPLINGS

Our new booklet, "Bulletin GB2," describes and illustrates the basic Dynamatic Eddy-Current units, including the new Stationary Field Coupling. If you are interested in modern speed control, write for your copy.

LIQUID COOLED BRAKES

Speed Control Problems?

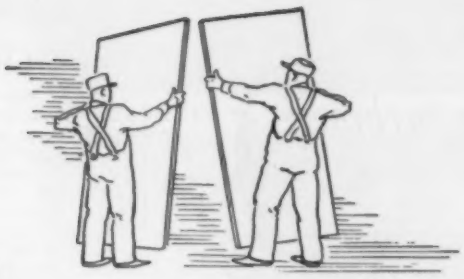
One of these Dynamatic Units may be the solution

Dynamatic Eddy-Current Couplings, brakes, clutches, Dynamometers, and Ajusto-Spede motors, in use today in practically every basic industry—in both plant equipment and end products—are proving the ideal solution to difficult speed control and testing problems. Advantages include rapid response, infinitely adjustable speed control, wide speed range, quiet operation, high full-load efficiency, low maintenance cost, adjustable speed from an AC power source. Write for your copy of the new Dynamatic Bulletin GB2 today.

DYNAMATIC®

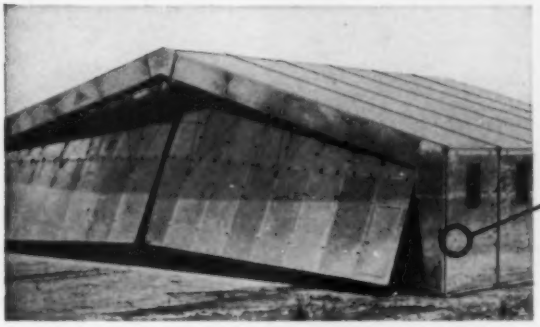
DIVISION EATON MANUFACTURING COMPANY

KENOSHA, WISCONSIN • General Offices: Cleveland, Ohio



Have you a similar fastening problem?

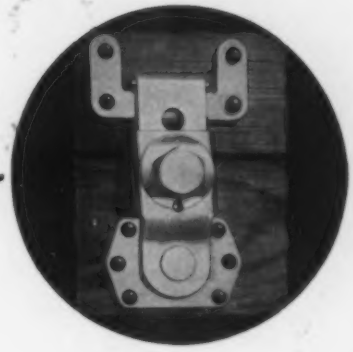
How a strong structure can be designed for speedy and simple assembly with unskilled labor, no special tools...



The U. S. Air Force wanted a jet-aircraft hangar design that would be portable by air, yet strong; would assemble quickly; be interchangeable, and flexible enough for easy structure modification.

The answer lay in a panel structure using modular units. Armorply honeycomb panels faced with thin aluminum, developed by United States Plywood Corporation, provide lightness, strength, flexibility. Joining one panel to the other in the field with untrained help was a problem until Simmons Fastener developed LINK-LOCK, a simple latching device that operates with minimum wrench pressure on hex nut.

This fastening problem is being successfully met by combining the design ingenuity of No. 1 LINK-LOCK with the proved performance of honeycomb plywood panels.



No. 1 LINK-LOCK—like No. 2 LINK-LOCK—features simplicity, positive action, high strength.

No springs are used in No. 1 LINK-LOCK. Locking action is obtained by rotating a nut that moves a sliding latch in and out of position. Up to 1500-lb. pull-down pressure is available; the device carries up to 4000-lb. tension. No. 1 LINK-LOCKS provide for surface mounting, simplifying installation.

Where can you use it? When you need heavy fastening pressures, resistance to impact, operation in 70-below temperatures—and where ease of action, compactness, and low cost are important factors. Write for a No. 1 LINK-LOCK Data Sheet.

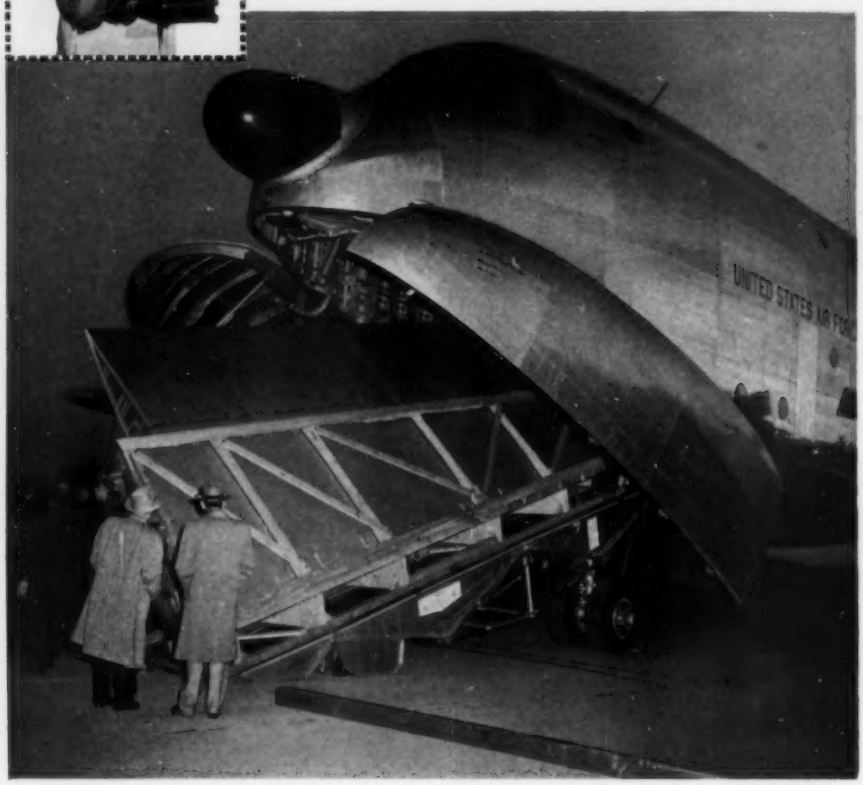
SIMMONS FASTENER CORPORATION
1751 North Broadway, Albany 1, New York

Simmons QUICK-LOCK SPRING-LOCK ROTO-LOCK LINK-LOCK DUAL-LOCK

JUST OUT! NEW 36-PAGE CATALOG WITH APPLICATIONS. SEND FOR IT!

Here right now...

This small gas turbine is a proven, working reality!



When it's loading time, and in emergencies, the giant Douglas C-124C, world's largest cargo plane, is vitally dependent on the Solar "Mars" Gas Turbine. This light weight engine drives the auxiliary generator providing power to operate cargo winches, doors, ramps, lights, engine starters and other equipment whenever the main engine generators are not operating.

The Solar "Mars" Gas Turbine

THE SOLAR "MARS" small gas turbine engine has proven its worth in standard operations, hour after hour. It has demonstrated rugged reliability by its trouble-free performance in airborne auxiliary generator sets.

The basic facts about this practical small gas turbine are its light weight (less than 100 lbs.); its size (smaller than a two-foot cube); its power output (approximately 50 hp); its simplicity, versatility.

The Solar "Mars" is powering generators on the Douglas C-124, and it will soon be standard equipment on the Lockheed C-121 military Super Constellation. It is also used to power portable fire fighting pumps and is under test for many other applications. Solar has also developed a 500 hp gas turbine, the "Jupiter," that is now being field tested for military and industrial uses.

Both the "Mars" and "Jupiter" have proved the theoretical advantages of gas turbines. Two great new small prime movers have been born.

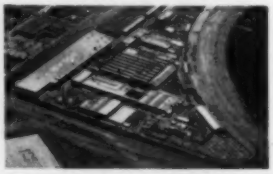
Today most Solar gas turbines are being delivered to military users, but soon they will be available to civilian industry.

SOLAR AIRCRAFT COMPANY — SAN DIEGO, DES MOINES

DESIGNERS, DEVELOPERS AND MANUFACTURERS OF METAL ALLOY PRODUCTS

This is What Solar Offers You

Solar specializes in the manufacture of precision products from alloys and special metals for severe service. Solar's experience since 1927 is unduplicated in this field. Solar skills and facilities range from research, design and development through to mass production. Wherever heat, corrosion or specifications are problems, Solar can help you solve them.



PLANTS. *In San Diego (Photo above) and Des Moines. A total of 1,400,900 sq. ft. floor space. Approximately 5,000 employees. Annual sales over $65,000,000.*

EQUIPMENT. *Production equipment for alloy and super metal fabrication—forming, machining, welding, brazing, casting, coating. Extensive laboratory and testing equipment. Facilities for development, prototype, limited or mass production.*

SERVICES. *Research, design, development, tooling and production engineering staffs. Experienced with all alloy steels, stainless alloys, super alloys, and Titanium and its alloys. Government source inspection and Solar quality control meet rigid aircraft and commercial standards.*

CONTRACT PRODUCTION

Current orders include aircraft engine and airframe parts, alloy castings, pneumatic ducting, atomic energy components. Customers include some of the most honored names among aircraft and industrial manufacturers in U.S. and Europe.

SPECIAL PRODUCTS

Bellows. *"Sola-Flex"® Bellows and Expansion Joints in many designs from ½" up to probably the world's largest, 28 feet in diameter.*

Gas Turbines. *Solar "Mars" 50 hp unit for auxiliary generator sets, portable fire pumps: Solar "Jupiter" 500 hp engines in variable and constant speed models.*

Ceramic Coatings. *"Solaramic"® is the Solar trade mark for a family of coatings that protects metals from heat, corrosion, galling and abrasion.*

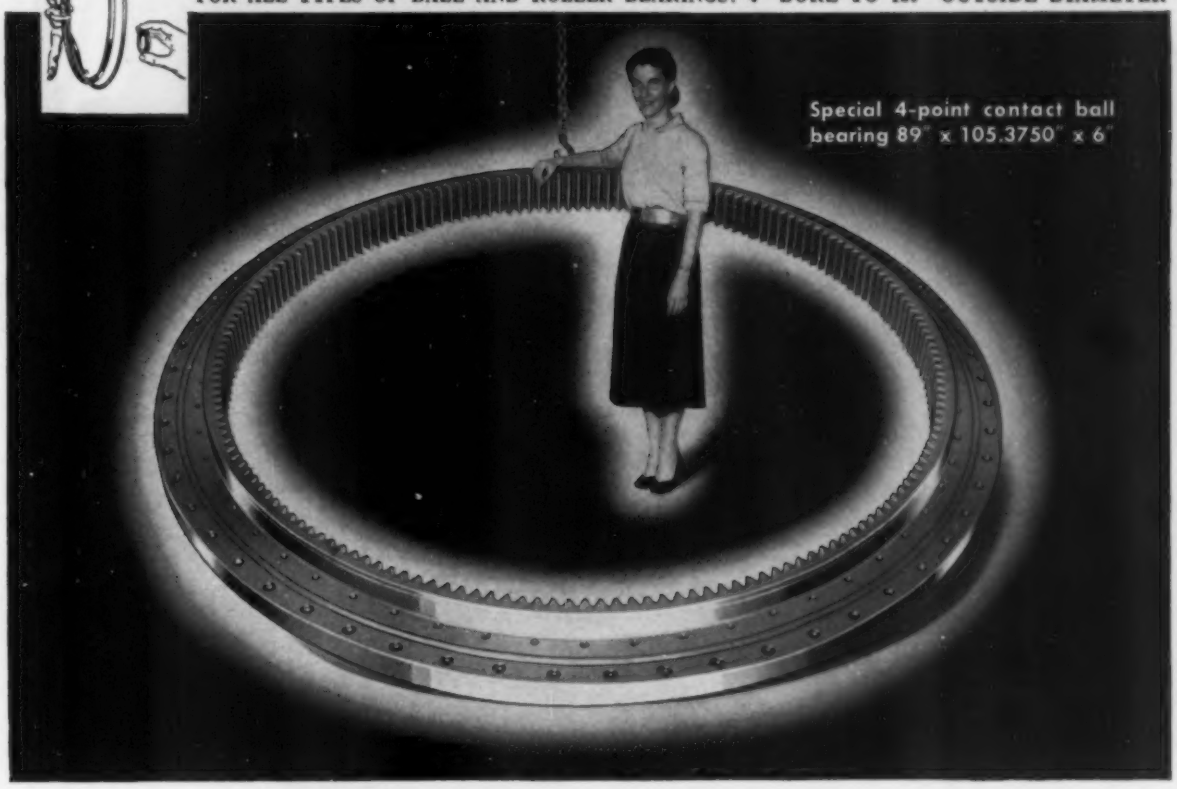
Controls. *Complete control systems utilizing the new Solar "Microjet"® principle for control of gas turbines, jet engines and pneumatic devices.*

FURTHER INFORMATION

Your inquiry regarding any Solar service or facility will receive courteous attention. Address Solar Aircraft Company, Department A-16, San Diego 12, Calif.

Contact KAYDON Muskegon

FOR ALL TYPES OF BALL AND ROLLER BEARINGS: 4" BORE TO 120" OUTSIDE DIAMETER

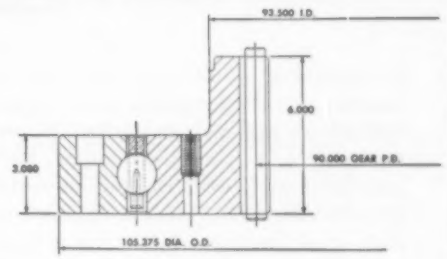


3000 pounds of precision— designed and built by Kaydon

This tremendous bearing, weighing a ton and a half and measuring 105.3750" in diameter, was **KAYDON**'s solution to one manufacturer's design problem. This bearing is typical of the many extraordinary requests which are everyday assignments for the **KAYDON** engineering department.

If you can improve your designs by being able to get special, thin-section and/or high precision bearings — contact **KAYDON** of Muskegon. Our bearing experts will be glad to cooperate, see that you get the bearings you need — on either a custom or mass production basis. Take a tip from a growing list of leading manufacturers who have found, "When it comes to special bearings, you'll save time and money by contacting **KAYDON** of Muskegon."

Details of the unusual bearing shown above—



Just Out! Get your copy of the new **KAYDON** *Reali-Slim thin bearing catalog No. 54.*

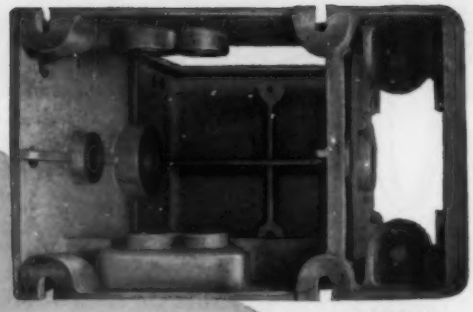
THE KAYDON ENGINEERING CORP.

MUSKEGON • MICHIGAN

KAYDON Types of Standard and Special Bearings:
Spherical Roller • Taper Roller • Ball Radial • Ball Thrust • Roller Radial • Roller Thrust • Bi-Angular Bearings

K548

PRECISION BALL AND ROLLER BEARINGS



BOTTOM

END

Figured from any angle...

SIDE

. . . this GRAY IRON casting does a better job for 50% less!

Production of a fabricated steel base for a press formerly cost the manufacturer approximately $302.00 for material and labor. By redesigning this base as a Gray Iron casting, the material and labor costs were reduced to approximately $150.00 . . . *a 50% saving!* Reduced machining time saved another 15%.

In addition to these substantial cash savings, the manufacturer also reports that this Gray Iron casting has proved to be a better all-around design than the fabricated steel base . . . both in appearance and in performance.

You, too, will find that it pays to use Gray Iron . . . from both engineering and economy angles. We will be glad to furnish you technical information on the many advantages of the Gray Iron casting process.

MAKE IT *BETTER* WITH GRAY IRON

75% of all cast metal products are Gray Iron

GRAY IRON FOUNDERS' SOCIETY, INC.

NATIONAL CITY-E. 6th BLDG., CLEVELAND 14, OHIO

Design to step up your machine performance, and you'll design to beat competition

Mr. W. B. Weathers, Manager, Machinery Electrification Sales, Westinghouse Electric Corporation

WESTINGHOUSE CAN HELP WITH THESE DRIVES

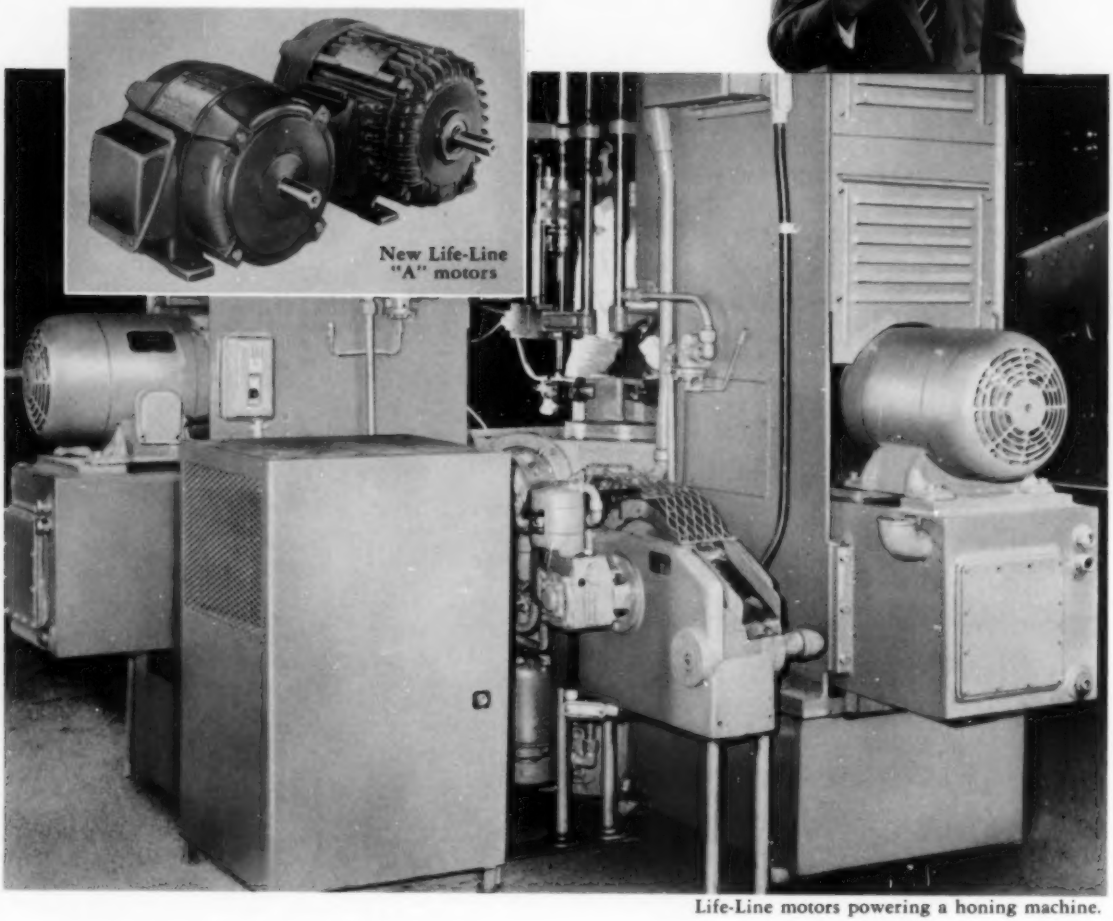
Here are some of the questions you have often asked yourself. How can we offer our customers new ways to higher uniform quality in manufactured goods? How can we offer lower production and maintenance labor costs, less down time, output spoilage and waste? How can we design the "answers" into our equipment?

The answers often lie in better application of electrical components, *to make maximum use of machine tools* and other production equipment, to power the equipment better and faster, to control that power precisely and unfailingly, and to sequence production operation to output requirements.

Then consider the extras Westinghouse Drives perform—better, longer, cheaper.

On the following pages, Mr. W. B. Weathers, Manager of Machinery Electrification Sales of Westinghouse Electric Corporation, shows how.

3 ways Westinghouse Drives take the measure of any production job



Life-Line motors powering a honing machine.

1. DESIGN FOR HIGHER PRODUCTION . . . New Life-Line® "A" better-protected motor gives greater reserve power for continual load changes

Rapid, extreme or repeated load changes mean heat. Consider these outstanding developments in the new Life-Line "A" cast-iron motor—a new, longer lived motor.

1. New Bondite, a silicone fortified thermoset varnish, means better temperature stability and better resistance to oil, water, chemicals . . . better protection for stator assemblies.
2. New Mylar*, a polyester film bonded to a reinforcing base, means slot insulation with greater dielectric and mechanical strength.
3. New Bondar, a conductor insulation, means more resistance to both heat and contaminants, with life expectancy more than 3 times that of the conventional conductor insulations.
4. New 4-way seal pre-lubricated bearing needs no lubrication . . . provides foolproof protection against under- or overgreasing, and against entry of foreign matter.

Consider these and many other new features in the new Life-Line "A". Why? Because the outage of Life-Line motors averages one-half that of conventional motors.

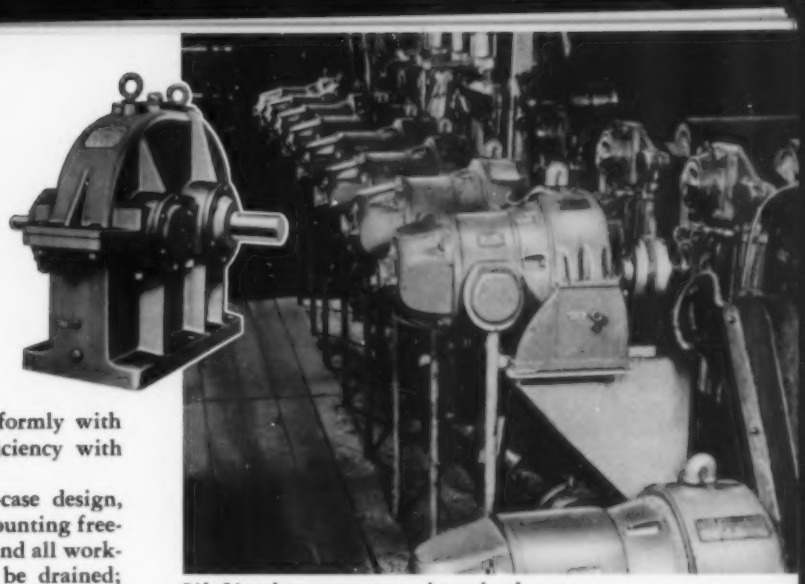
Westinghouse carries a complete line of motors—both a-c and d-c—for all of your motor requirements.

2. DESIGN FOR SPEED-REDUCTION EFFICIENCY . . . Life-Line gearmotors provide full range of speeds at 98% efficiency

Wherever gear reduction drives are required, Life-Line gearmotors, designed and manufactured com-

* Du Pont Registered Trade-Mark

YOU CAN BE SURE...IF IT'S



Life-Line d-c gearmotors and speed reducers

plete by Westinghouse, transmit power uniformly with a loss of 2% for each gearset—a 98% efficiency with single reduction units.

Because of their unique horizontal split-case design, Westinghouse Gearmotors provide greater mounting freedom. Case cover can be removed in minutes, and all working parts are then accessible. No oil need be drained; gearmotor mounting need not be disturbed! All bearings are firmly anchored in case foundation to assure positive bearing alignment and elimination of harmful vibrations.

Consider Westinghouse Gearmotors—the most efficient, versatile, reliable buy.

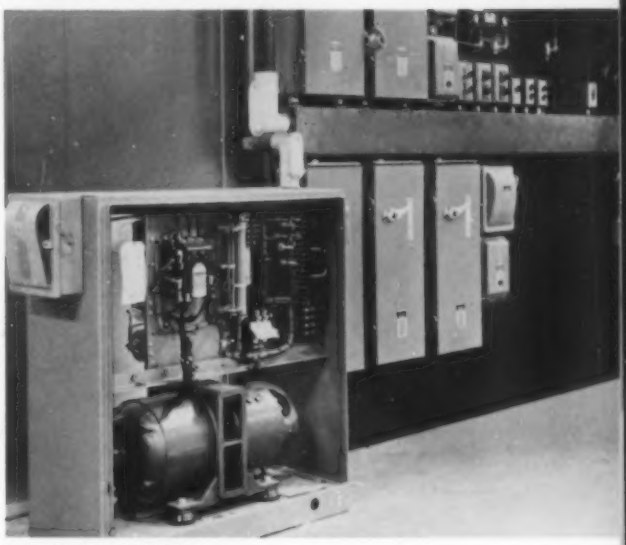
3. DESIGN FOR FINER SPEED ADJUSTMENT . . . with compact AV drive power package

The Westinghouse AV Drive enables you to provide d-c power from an a-c line, for individual machine tools or other equipment—on-the-spot power conversion. This drive is a complete, adjustable-voltage drive system, a factory-engineered package.

Consider these further advantages. With precise speed control, you can:

1. Provide smooth acceleration and deceleration.
2. Maintain optimum operating speeds regardless of load changes.
3. Match speeds of two or more drives to coordinate production processes.
4. Add many other functions such as inching, reversing, interlocking and sequencing, etc.

So, if you need fast, accurate control of speed over a wide range, consider the Westinghouse complete line of AV Drives.

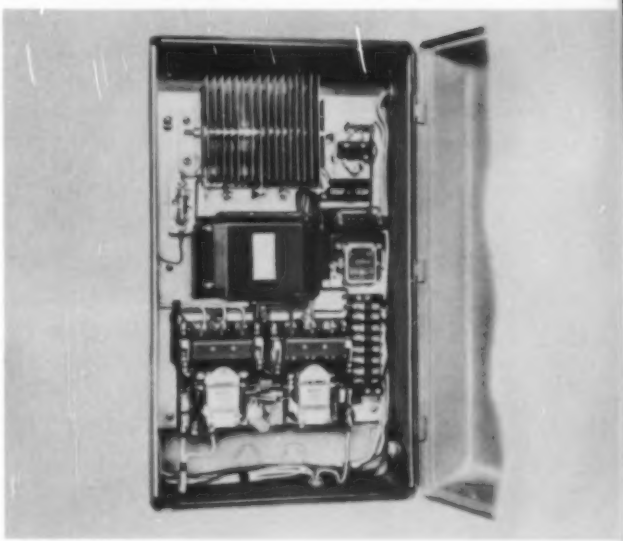


Westinghouse AV Drive

AND HERE'S FASTER BRAKING . . . electrical braking control provides smoother, quicker stops

Here's a method of stopping a motor faster and more smoothly. Most machines can be brought to a standstill, under normal load, in just one second. This d-c braking controller eliminates jerky operations, wear of parts and periodic adjustment often associated with mechanical brakes. Its applications are many—it can be used where quick stops are necessary to permit tool changes, or to prevent damage to work or machine; where the possibility of reversal must be eliminated; or, where the same degree of braking is required in either direction.

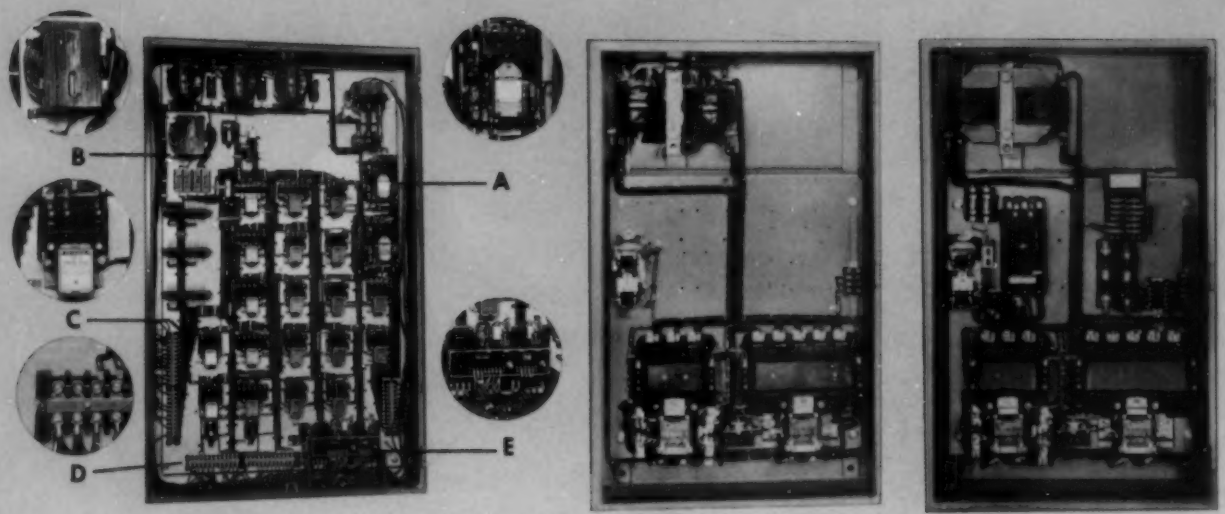
It will pay for itself by reducing coasting and nonproductive work time, reducing waste, improving product quality, improving safety, and saving space taken up by mechanical devices.



D-c braking control

Westinghouse

Further information on the following page ▶



(Left photo) **All-Westinghouse Panel** controlling honing machine: (A) Life-Line Starter, (B) Control Circuit Transformer, (C) Type N Relay, (D) Terminal Blocks, (E) Actotran.

(Middle photo) **Add-a-Part Panel** with provision for additional units. (Right photo) **Same Add-a-Part Panel** after addition of components.

Westinghouse
AB Circuit Breaker

Full line of control components to contact, relay, interlock and break circuits

The typical machine tool control cabinet illustrated is equipped with all-Westinghouse components. These devices can be furnished for your machines either singly or in completely engineered and mounted panels to your specifications.

Control components—such as starters, contactors, relays, timers, breakers, switches, control circuit transformers, terminal blocks, and so on—providing for individual functions, may be combined to coordinate many control functions including starting, stopping, reversing, inching, regulating, protecting and switching.

Add-a-Part Panel

Add-a-Part Panels are the newest and most versatile innovation to the reduced voltage starter line—and exclusive with Westinghouse. Add-a-Part is your assurance of complete application flexibility. Panels have drilled and tapped holes to accommodate required modifications on the spot to meet changing application conditions. Simply add transformers, fuses, interlocking relays, breakers or timing relays.

Only Westinghouse can offer Add-a-Part's savings in time, money and flexibility.

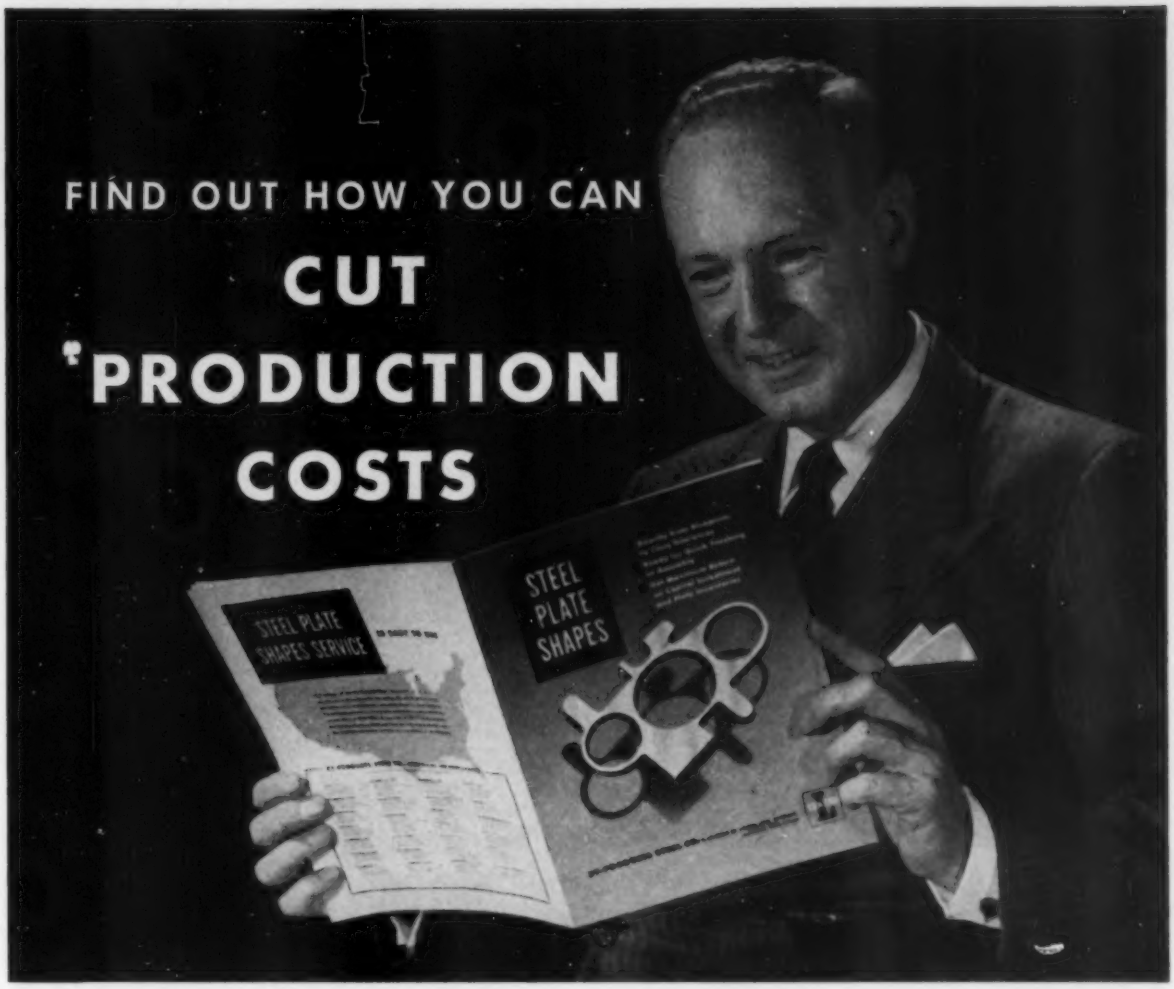
Prompt, reliable maintenance backs up your Westinghouse Equipment

38 large apparatus repair shops coast to coast provide your customers maintenance for all types of electrical equipment. 56 field repair offices make on-the-spot repairs; 31 locations provide Genuine Westinghouse Renewal Parts. Extend your service with Westinghouse Service.

Here's help with literature; write to Westinghouse Electric Corporation, 3 Gateway Center, P. O. Box 868, Pittsburgh 30, Pa. *New Life-Line "A" Motor* **B-6154**; *Life-Line SK D-C Motors and Generators* **B-4595**; *Life-Line AV Drive* **B-5808**; *Life-Line Gearmotors* **B-5645**; *Speed Reducers* **B-5646**; *Automatic Operations Start with Westinghouse Control* **B-5882**; *Complete Industrial Control and Services* **B-6051**; *Preventive Maintenance* **B-5477**.

MP-3027

YOU CAN BE **SURE**...IF IT'S Westinghouse



This new book on Steel Plate Shapes Service can show you how to save time, money and manpower in production with preformed component parts. Here's how this booklet can help you to cut production costs.

Steel Plate Shapes Service helps you eliminate one or more production steps, free your machines for other work, speed your manufacturing operations. Formed to close tolerances from rolled steel plate, these shapes save fit-up time . . . can often be used without machining. You save by paying freight only on the part you use, reduce costly steel plate inventories, get rid of the headache of scrap handling and scrap losses.

You get plate that's shaped to save you money—formed to your specifications. We work directly from blueprints. Over 150 major machines are available to flame-cut, shear, blank, press, bend or otherwise form rolled steel plate. Parts can be furnished as formed, or rough- or finish-machined. We also maintain a large stock of standard dies of all types.

FOR FULL INFORMATION on Steel Plate Shapes Service, send for Bulletin 712. The coupon or a request on your company letterhead will bring a free copy at no obligation. Address By-Products Steel Co., 672 Strode Avenue, Coatesville, Pa.

LUKENS

BY-PRODUCTS STEEL CO.

A Division of
Lukens Steel Company

BY-PRODUCTS STEEL CO.
673 Strode Avenue
Coatesville, Pa.

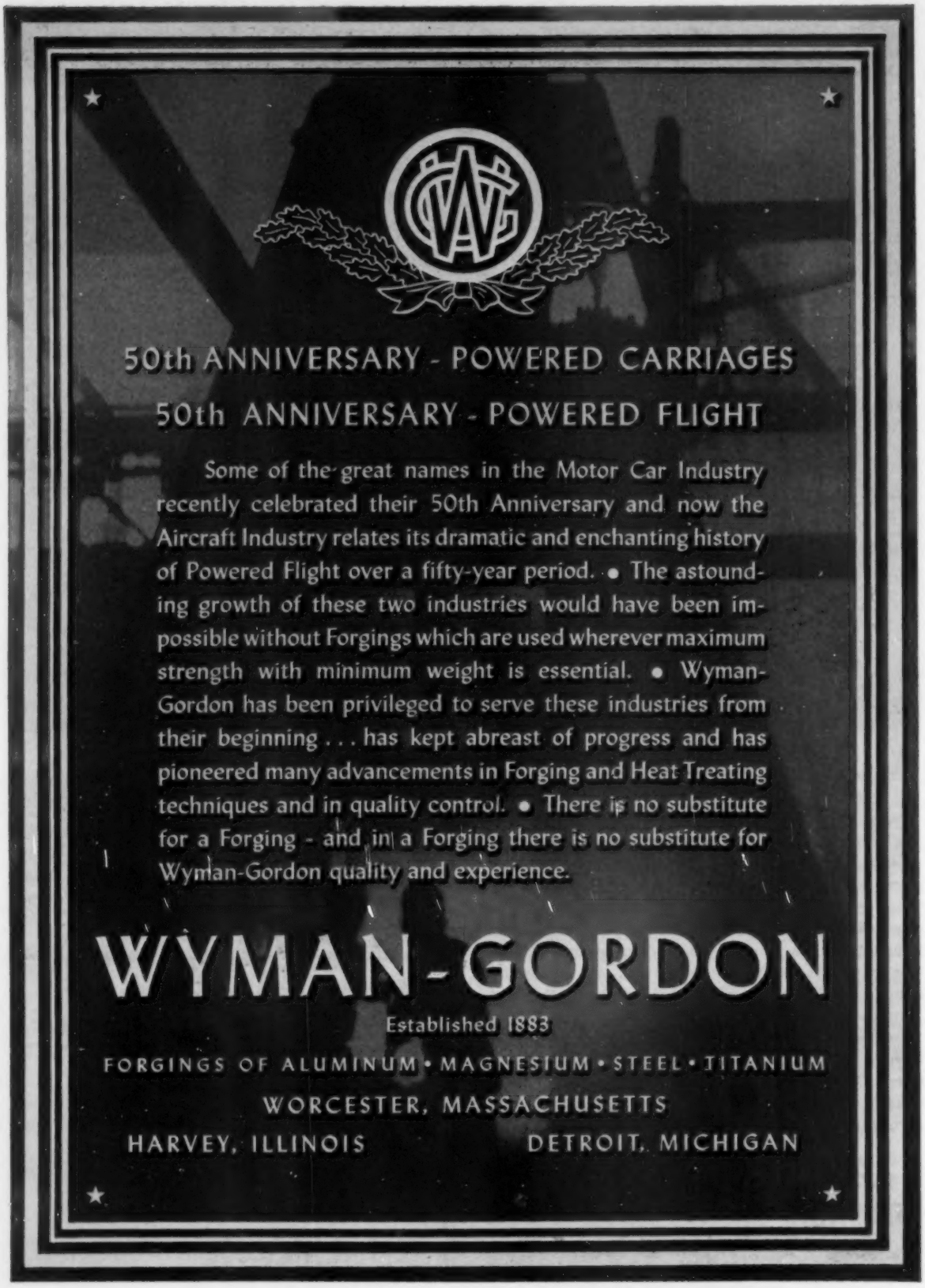
Please send me a free copy of Bulletin 712.

NAME.....

TITLE.....

COMPANY.....

CITY.....ZONE.....STATE.....


50th ANNIVERSARY - POWERED CARRIAGES
50th ANNIVERSARY - POWERED FLIGHT
Some of the great names in the Motor Car Industry recently celebrated their 50th Anniversary and now the Aircraft Industry relates its dramatic and enchanting history of Powered Flight over a fifty-year period. • The astounding growth of these two industries would have been impossible without Forgings which are used wherever maximum strength with minimum weight is essential. • Wyman-Gordon has been privileged to serve these industries from their beginning . . . has kept abreast of progress and has pioneered many advancements in Forging and Heat Treating techniques and in quality control. • There is no substitute for a Forging - and in a Forging there is no substitute for Wyman-Gordon quality and experience.
WYMAN-GORDON
Established 1883
FORGINGS OF ALUMINUM • MAGNESIUM • STEEL • TITANIUM
WORCESTER, MASSACHUSETTS
HARVEY, ILLINOIS
DETROIT, MICHIGAN

DELCO MOTORS

the best running mate your product can have

Millions of Delco Motors—fractionals and integrals—are giving reliable service in the operation of farm equipment, home appliances, tools and machinery of every sort.

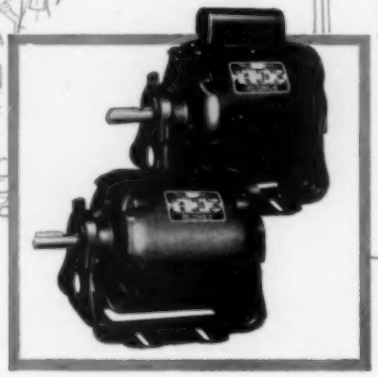
Such wide usage suggests that Delco Motors give a good account of themselves, performance-wise. Such user acceptance suggests, too, that you would find a Delco Motor the best running mate for *your* product.

DELCO PRODUCTS

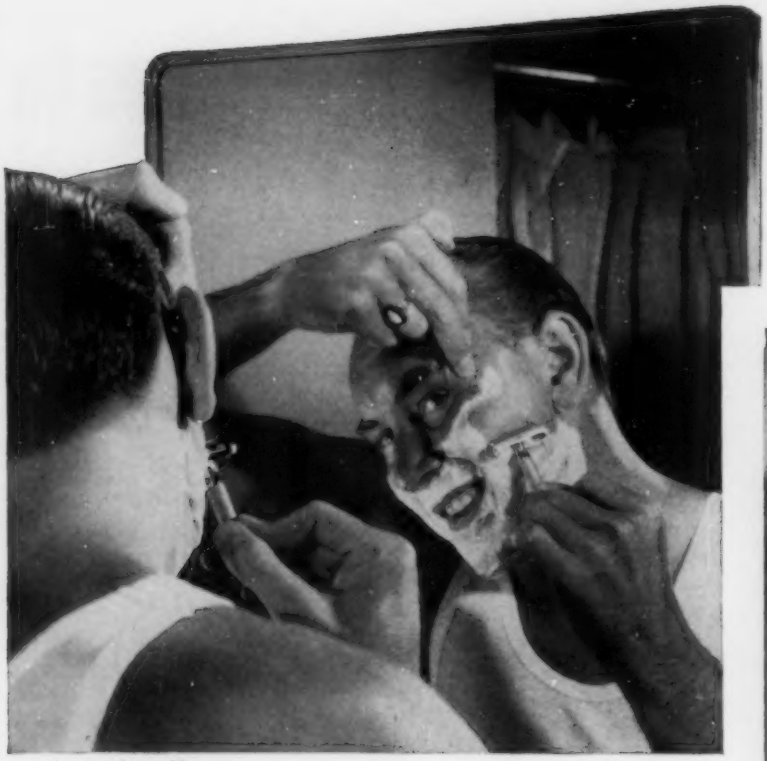
DIVISION OF GENERAL MOTORS CORPORATION
DAYTON 1, OHIO

SALES OFFICES:

Atlanta • Chicago • Cincinnati
Cleveland • Dallas • Detroit
Evansville • Hartford • Kansas City
Los Angeles • Philadelphia
St. Louis • San Francisco
Syracuse

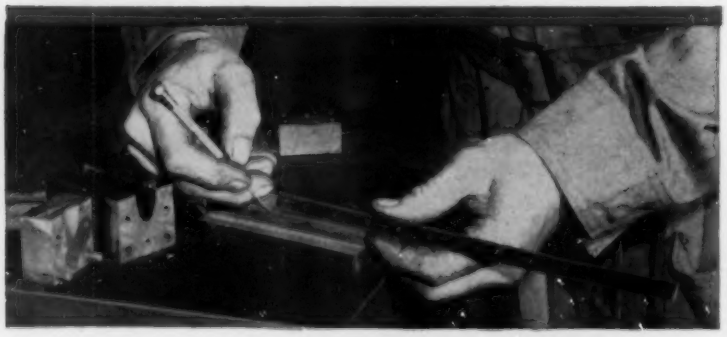


You can get for any of



Blades Stay Sharp. Special precautions are taken with Amerstrip Razor Blade Steel to see that it is *clean* and free of impurities, to see that it won't chip or nick when honed. This special alloy steel takes a good sharp edge that *stays* sharp, shave after shave.

Hand or Band Saws. Amerstrip Saw Steel is hard, strong, durable, and flexible—just what you need in saws. The steel is free of defects, ready for toothing and cutting to length. Available for wood or steel saws.



Straight and Flat is the Rule. Camber and flatness are closely controlled in Amerstrip Rule Steel to insure accuracy. This steel is available tempered or untempered, cut or coiled, in a wide range of sizes.

Amerstrip is a Staple. Amerstrip Staple Wire is hard rolled for good penetration, and it folds without cracking. Clean and bright, it is galvanized to resist corrosion. A wide range of sizes to fit many uses.

Toe Saver. Amerstrip Toe Cap Steel is used extensively to reinforce the toes of safety shoes. It is high carbon steel, furnished in coils with a #3 edge, ready for stamping.

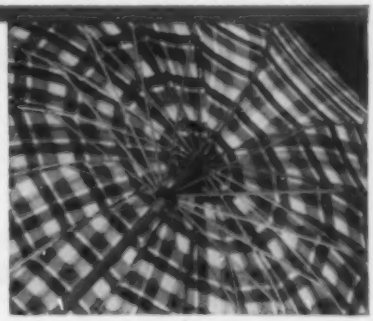
high quality Amerstrip these specialty products

De-Jolting Mechanism. In automobile shock absorbers, discs of Amerstrip help to regulate the flow of oil to cushion bumps and jolts. Close attention is paid to temper and flatness to lengthen fatigue life.

For Measuring Thousandths. Amerstrip Feeler Gauge Steel is extremely flat, uniform, and rolled to close tolerances. It is available with a #1 edge, bright tempered, in thicknesses from .0015" to.025".

For Stopping Stuck Shades. High carbon Amerstrip Curtain Spring Wire assures good strong winding action on window shades, portable projection screens, schoolroom maps, and similar products. In coils, in all standard sizes.

High Honking Power. Only a flat, scaleless, tempered high carbon strip can withstand the high stresses and fatigue encountered in automobile horn diaphragms. Amerstrip Diaphragm Steel is made especially for this tough job.



Bumbershoots. Amerstrip Umbrella Wire is used in ribs and bows of umbrellas. It is straight, formable, and smooth. Special sizes of this high carbon annealed wire are stocked. Every phase of manufacture is controlled closely.

FOR MORE INFORMATION— Write your nearest American Steel & Wire sales office.

AMERICAN STEEL & WIRE DIVISION, UNITED STATES STEEL CORPORATION
GENERAL OFFICES: CLEVELAND, OHIO

COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO, PACIFIC COAST DISTRIBUTORS
TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA., SOUTHERN DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

Amerstrip

CARBON • ALLOY USS STAINLESS

UNITED STATES STEEL

You're on the ball when you

Keep your eye on RUBATEX

Cutting costs is music to the ears of product designers, industrial engineers and purchasing agents...and Rubatex Gaskets can mean real cost cutting for you. Rubatex Gaskets are cheaper and more dimensionally accurate than molded parts ...Rubatex's closed cellular structure completely shuts out moisture, oxygen, dust—even at cut edges thus eliminating any need and expense of special coating or molded-on skin... can be cut from sheet stock—any size, any shape...takes up large dimensional tolerances so that plastic and glass parts can be tightened down to a good seal *with no danger of breakage!*

For air that protects use Rubatex!

If you have a gasketing, cushioning or sealing application — investigate the cost-saving advantages of Rubatex first. For further information, write for our latest catalog, Dept. PE-9, Great American Industries, Inc., Rubatex Division, Bedford, Virginia.

ALSO MANUFACTURERS OF VINYL SHEETS

Typical pallet shipment of Torrington Needle Rollers showing two boxes of 20 cans each strapped to pallet. Open box of cans in foreground.

Torrington Needle Rollers—Vacuum-Packed for Cleanliness—Palletized for Easy Handling

Torrington Needle Rollers by the millions are now being vacuum-packed in tin cans to protect them from dirt, moisture and damage. The foods you eat are not packed with greater care.

This new vacuum pack permits us to send you rollers *dry*—free from oil or grease—so that they can go into your loading machines direct from the can, without time-consuming degreasing.

To make shipping and handling easier, we pack these cans 20 to a carton and strap two cartons to an expendable wooden pallet, for a total weight of about 1500 lbs. per pallet. This makes an easy load for your fork lift trucks to handle and store.

Torrington Needle Rollers deserve this special vacuum pack. They're precision rollers made under statistical quality controls of extraordinary rigor. Every step from alloy selection to polishing and packing is carefully checked to assure you that every can of rollers you receive meets your high standards. And to help you use these rollers to best advantage, Torrington's engineering staff is always available to assist in application design and testing.

Always specify Torrington for precision Needle Rollers in prime condition. In stock for immediate volume shipment.

THE TORRINGTON COMPANY

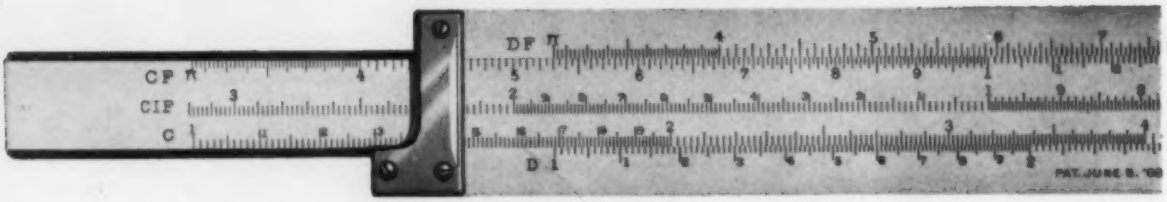
Torrington, Conn. South Bend 21, Ind.

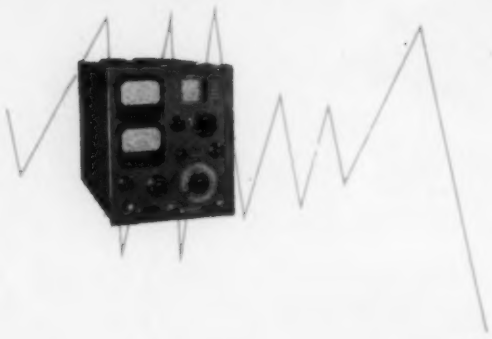
District Offices and Distributors in Principal Cities of United States and Canada

TORRINGTON NEEDLE BEARINGS

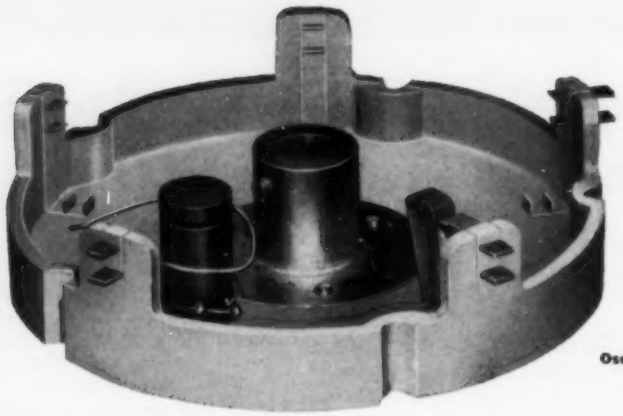
Needle • Spherical Roller • Tapered Roller • Cylindrical Roller • Ball • Needle Rollers

Where precision is essential...





industry turns to PLASKON® Alkyds



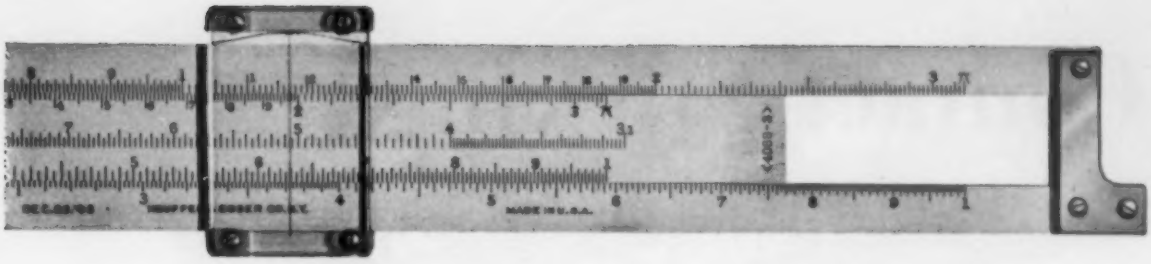
Oscillator Turret

THE HEWLETT-PACKARD COMPANY of Palo Alto, California, as a manufacturer of electronic equipment, has found that PLASKON Alkyds molding compounds can and do meet all of their exacting specifications!

In the VHF Signal Generator pictured above, for instance, a material was needed that could guarantee *absolute* dimensional stability to a component part, thus assuring the instrument's unfailing accuracy. It had to be strong enough to hold silver inserts without loosening during a life of 50,000 cycles. It had to have a low coefficient of thermal expansion, be readily molded and offer high resistance to heat and arcing.

According to Hewlett-Packard, glass-reinforced PLASKON Alkyd molding compound is "the only plastic that met all our requirements." In other instruments, H-P has had equal success with PLASKON Products using both mineral-filled and glass-reinforced alkyds.

We pass this "success story" on to you, with the thought that what PLASKON Products can do for others, they can do for *you* too.



1. Transformer Terminal

2. Transformer Bobbin

3. Probe body insulator

4. Coil Case

"PLASKON Alkyd molding compounds' fast cure has cut our costs considerably," says Ralph E. Lee, production engineer at Hewlett-Packard. "We also get appreciable savings by molding parts such as probe body insulators which formerly had to be machined. PLASKON Alkyd molding compounds' outstanding electrical properties result in higher quality for our components too."

1. PLASKON Alkyd molding compounds give these transformer terminals high insulation and moisture resistance.

2. Transformer bobbins have high strength, even when walls are molded as thin as .040".

3. Probe body insulator has a resistance of at-least 100,000 megohms between terminals, with dimensional stability over long periods at 150°F.

4. Through using PLASKON 422 Alkyd molding compound H-P cuts costs by building only one cavity mold for coil cases instead of many.

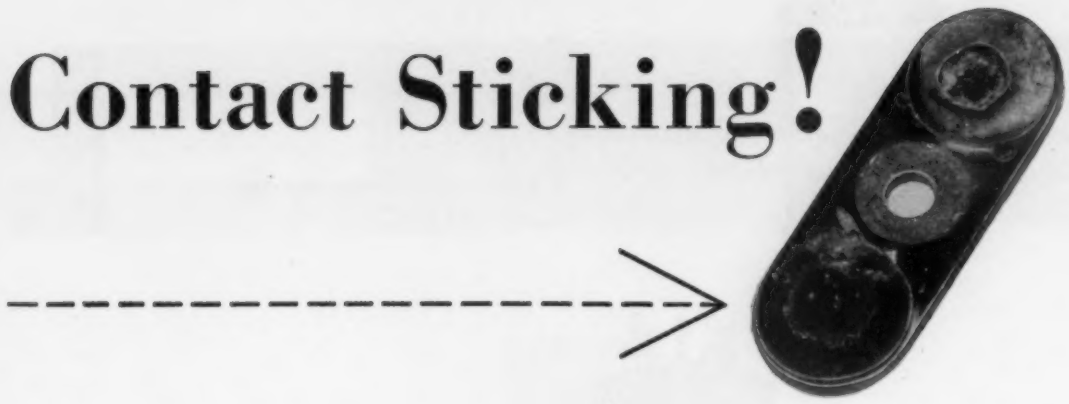
Barrett PLASKON®

For further information on PLASKON Plastics and Resins address BARRETT DIVISION, Allied Chemical & Dye Corporation, 40 Rector St., New York 6, N. Y. Hanover 2-7300

Allied Chemical

Reduce

Contact Sticking!



Mallory Silver-Cadmium Oxide will give you an improved combination of high conductivity and anti-sticking qualities.

In applications where silver or silver alloy contacts tend to stick or erode under arcing, Mallory Silver-Cadmium Oxide Contacts are often the solution to better performance.

Mallory Silver-Cadmium Oxides are composition materials with greater resistance to sticking and erosion than fine silver, and higher conductivity than true alloys of the same materials. Here are two examples of its performance . . .

In overload tests on aircraft relays, Mallory Silver-Cadmium Oxide Contacts interrupted 250% more current than fine-silver without welding.

In a 440-volt AC motor controller test, Mallory Silver-Cadmium Oxide Contacts resisted arc erosion 40% better than fine-silver.

To manufacturers of relays, motor starters, controls and limit switches, Mallory Silver-Cadmium Oxide Contacts can mean significant improvement in performance and life. They may permit a substantial increase in the electrical rating of your equipment, without increase in size. Yet, cost is often no greater than for fine-silver contacts.

Get All The FACTS

Write for your copy of the new Mallory Contact Catalog. It contains a complete description of all Mallory materials and facilities for producing contacts and contact assemblies for every service . . . as well as valuable technical and design data.

Expect more . . . Get more from MALLORY

Serving Industry with These Products:

Electromechanical—Resistors • Switches • Television Tuners • Vibrators
Electrochemical—Capacitors • Rectifiers • Mercury Batteries
Metallurgical—Contacts • Special Metals and Ceramics • Welding Materials

P. R. MALLORY & CO. Inc.
MALLORY
P. R. MALLORY & CO., Inc., INDIANAPOLIS 6, INDIANA

Greatest variety, largest resources for PLASTIC EXTRUSION MATERIALS KEYED TO YOUR NEEDS!

Your best assurance of getting exactly the extrusion material you need is the range of resins and compounds available from Bakelite Company.

Colors are practically limitless with BAKELITE *Vinyl Plastics*, which include the clearest belting compound available. They can be printed or embossed, and have superior gloss. That's why they're so practical for women's belts, venetian blind tapes, zippers, and tubing. Their flexibility, toughness, and resistance to chemicals and weather make them useful for wire covering.

For extremely light weight, use BAKELITE *Polyethylene*. It's also noted for its dielectric strength and resistance to chemicals, making it useful for wire insulation, chemical tubing, flexible pipe. Extruded sheets are being used for vacuum forming. A cellular, expanded form of polyethylene further reduces weight for uses such as TV twin-lead wire.

Bakelite Company supplies other extrusion materials – *polystyrenes, impact styrene plastics, acrylonitrile-styrene plastics.* Keep up with the new developments in this fast-growing field by adding your name to the mailing list for the new BAKELITE Extrusion News. Write Dept. YM-10.

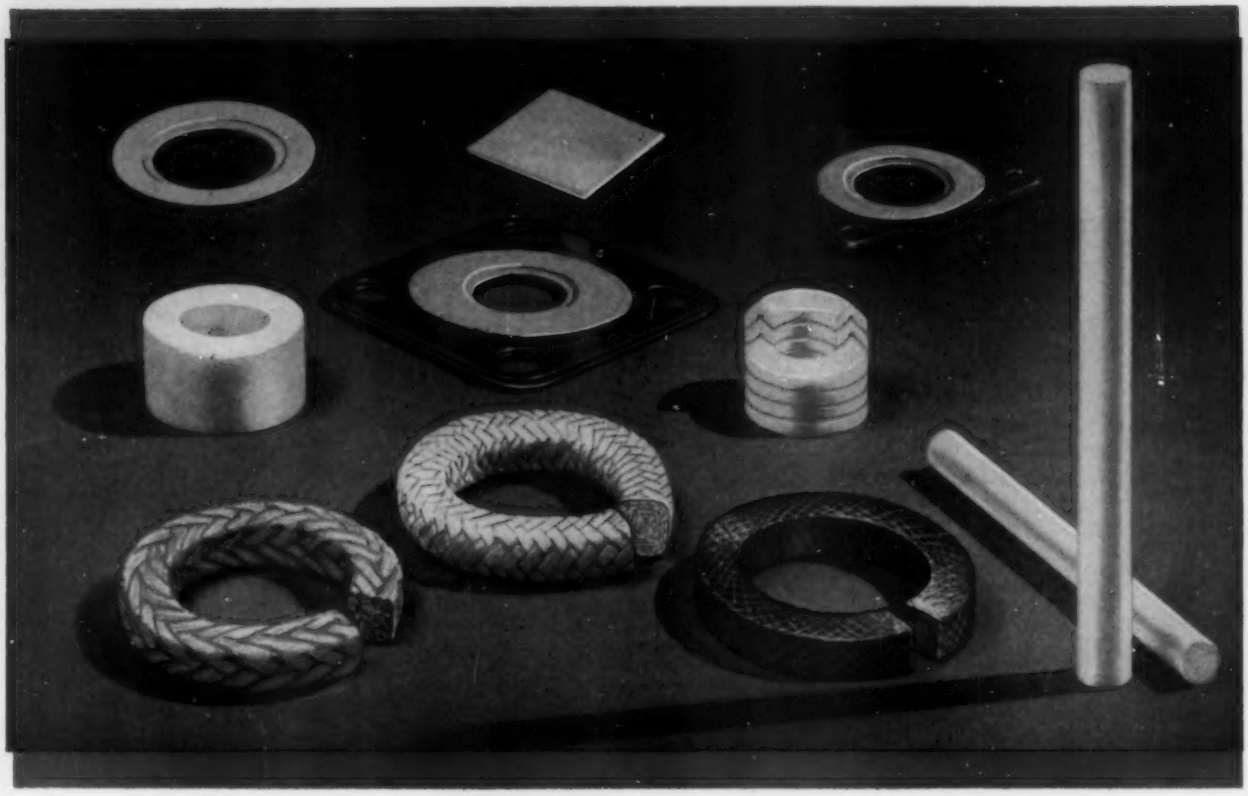
BAKELITE
TRADE-MARK
EXTRUSION MATERIALS

TRADE MARK

BAKELITE COMPANY
A Division of
Union Carbide and Carbon Corporation
UCC
30 East 42nd Street, New York 17, N. Y.

Polyethylene, Polystyrenes, Impact Styrenes, Vinyls, Acrylonitrile-Styrenes

CALL ON R/M ENGINEERING SERVICE



PERHAPS YOU NEED AN R/M TEFLON* PACKING

If you are designing or making equipment to handle acids, caustics or other chemicals, you will want to look into R/M Teflon Packings and Gaskets. By using packings made of R/M Teflon, engineers are getting some amazing results. This is because of the combination of advantages it offers. R/M Teflon is not affected by chemicals within the temperature range of -80°F. to 500°F.; has high heat stability; is completely nonabsorbent of water; is not affected by the weather; is non-adhesive, nonflammable, and possesses excellent electrical properties. The R/M line of Teflon Packings and Gaskets includes valve stem packings, stuffing box rings, Vee-Flex® rings, envelope gaskets, "French" gaskets, solid rings and shapes cut from Teflon sheet, rods and tubes.

R/M also makes a highly diversified line of packings for use against air, gas, water, steam, oil, solvents, foods and hydraulic fluids. And if your needs include asbestos textiles, R/M can furnish them, too—in the form of cloth, yarn, roving or tape.

Whatever your packing problem, call on R/M's specialized Packing Engineering Service. Get the advantage of R/M's experience, facilities and unmatched skills. Send for booklet on packings, gaskets, and Teflon products.

Du Pont's trade-mark for its tetrafluoroethylene resin

For booklet shown, or other data, write, phone or wire:

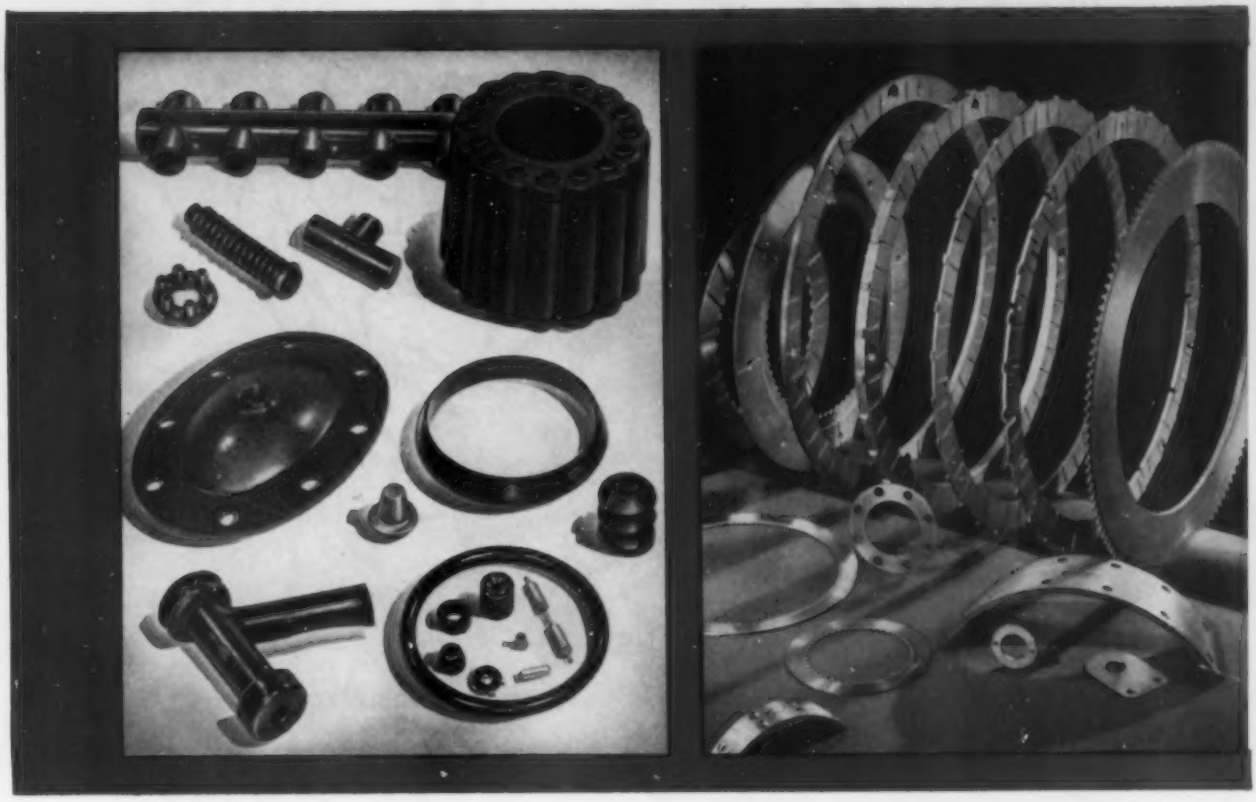
PACKING DIVISION OR ASBESTOS TEXTILE DIVISION
Raybestos-Manhattan, Inc.
Manheim, Pa.
Manheim 5-2211

R/M

SPECIALISTS IN ASBESTOS, RUBBER, SINTERED METAL, ENGINEERED PLASTICS

Brake Blocks, Linings and Clutch Facings | Fan Belts and Radiator Hose | Mechanical Packings and Gaskets | Abrasive and Diamond Wheels | Industrial Drive Belts | Industrial and Automotive Hose

FOR HELP IN SOLVING YOUR PROBLEMS



MOLDED PARTS **Rubber, Silicone, Nylon**

R/M gives you custom-engineering on molded, cut and extruded parts made of natural or oil-proof synthetic rubber, silicone or nylon to insure long life and trouble-free service in all conditions of use. For example, Parock Oilless Bearing Material for wet operation is a typical R/M development to solve a tough machine design problem. R/M rubber hose, conveyor and transmission belts, and V-belts are described in our "Exclusive Features" book. Let R/M work with you. Ask about Manhattan Rubber Division's Specialized Engineering Service.

For booklet shown, or other data, write, phone or wire:

MANHATTAN RUBBER DIVISION
Raybestos-Manhattan, Inc.
Passaic, N.J.
Gregory 3-2000

SINTERED METAL PARTS

If you have a friction material application that requires close tolerances or an operating condition that calls for immersion in oil, R/M can provide you with an element engineered to your specific needs. It can also meet your requirements for woven and molded asbestos or semimetallic friction materials. Feel free to call on R/M engineering service for advice on any problem which involves friction materials. For detailed information about R/M brake linings, clutch facings and special shapes of friction materials send for booklet today.

For Bulletin No. 500, or other data, write, phone or wire:

EQUIPMENT SALES DIVISION
Raybestos-Manhattan, Inc.
6010 Northwest Highway
Chicago 31, Ill.
ROdney 3-2400

RAYBESTOS-MANHATTAN, INC.

FACTORIES: Passaic, N.J. • Neenah, Wis. • Manheim, Pa. • Bridgeport, Conn. • No. Charleston, S.C. • Crawfordsville, Ind. • Peterborough, Ontario, Canada

Conveyor Belts

Rubber Lined and Covered Equipment

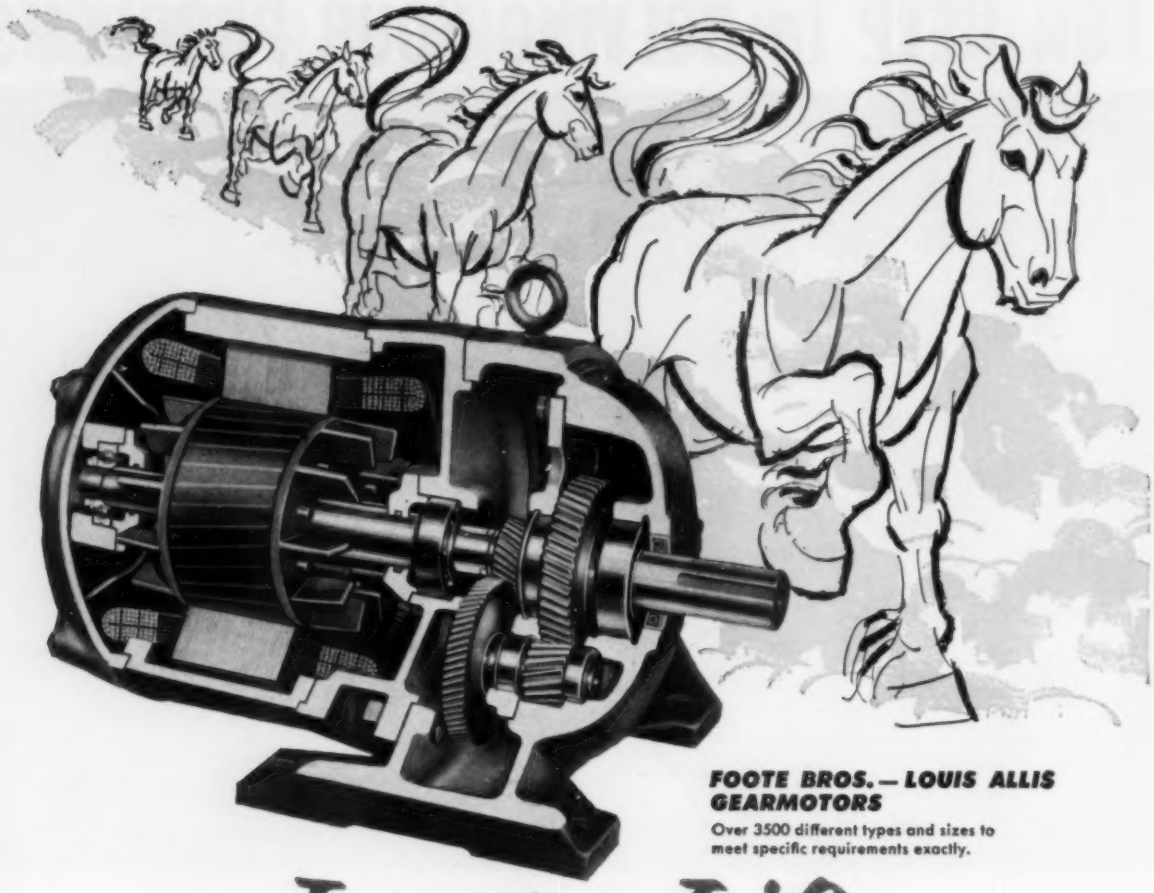
Sintered Metal Friction Elements

Asbestos Textiles

Teflon Tape, Packings, Sheets, Rods, Tubes

Engineered Molded Rubber and Plastics

R M



FOOTE BROS.—LOUIS ALLIS GEARMOTORS

Over 3500 different types and sizes to meet specific requirements exactly.

Longer Life

with Less Maintenance

FOOTE BROS. Duti-Rated LIFETIME GEARING

FOOTE BROS.

Better Power Transmission Through Better Gears

Manufacturers of industrial gears and enclosed gear drives of all kinds, gearmotors, aircraft-quality gears, actuators and special machinery.

Write for complete details...

Get all the facts and figures on how Foote Bros. drives with Duti-Rated Lifetime Gears can fit into your production picture. Write today . . . or see your local Foote Bros. representative now!

WITH FOOTE BROS.

Duti-Rated LIFETIME GEARS

Now when you install an enclosed gear drive with Duti-Rated Lifetime Gears, you *know* it will give you the longer, trouble-free performance you're looking for! And for your applications, Foote Bros. offers you 2 different drives . . . famous Foote Bros.—Louis Allis Gearmotors and proven Foote Bros. Line-O-Power Drives. Both incorporate the world's finest industrial gearing, Duti-Rated Gears . . . a unique and revolutionary development by Foote Bros. that offers super-hard precision gears with much longer life and higher capacity than ordinary industrial gears . . . in much less space. For performance you can measure, quality you can trust—always insist on dependable Foote Bros. drives with longer-lasting Duti-Rated Lifetime Gears!

LINE-O-POWER DRIVES

Feature space saving, longer life Duti-Rated Lifetime Gears. Available in double and triple reductions with ratios from 5 to 1, up to 238 to 1; capacities range up to 200 h.p.

FOOTE BROS. GEAR AND MACHINE CORPORATION • 4545 SOUTH WESTERN BOULEVARD • DEPT. W • CHICAGO 9, ILLINOIS

If your plans call for these features

call for

BAKELITE[4]
TRADE-MARK

Polyethylene

LIGHT WEIGHT

Light weight means economy wherever you use polyethylene, the lightest commercial plastic. One man easily carries a 200-ft. coil of 2-in. polyethylene pipe. Polyethylene carboys cut shipping costs of liquid chemicals. Wire and cable covered with polyethylene can be strung over longer spans, saving poles.

FLEXIBILITY

Flexibility is an inherent feature of polyethylene. It needs no plasticizers to make it resilient. The degree of its flexibility depends on its wall thickness. Squeeze bottles made from it recover their shape instantly. This quality means lower breakage costs for articles made from polyethylene.

TOUGHNESS

Toughness is another valuable property of polyethylene. A good example is this auto spring leaf pad of molded polyethylene. It stands up under constant squeezing and acts as a "dry lubricant," preventing metal-to-metal contact. It keeps out sand and grit that could abrade the metal spring leaves.

ABRASION RESISTANCE

Abrasion resistance is superior in comparison with rubber-type compounds. In laboratory test using a revolving drum covered with "Aloxite" 320 metal cloth to provide continuous abrasion, rubber-type compound lost 75 to 80 per cent thickness in only 280 revolutions. Polyethylene lost 40 to 45 per cent in 2000 revolutions.

Polyethylene can be molded, extruded, formed into film, used to fortify wrapper waxes. It's in plentiful supply. It may be the best way to turn your new product ideas into immediate application. Learn more about it by writing Dept. YO-10.

BAKELITE COMPANY
A Division of Union Carbide and Carbon Corporation UCC
30 East 42nd Street, New York 17, N. Y.
In Canada:
Bakelite Company, Division of Union Carbide Canada Limited, Belleville, Ontario

Plenty of Copper...

today and tomorrow

The assurance that copper is in abundant supply and *can be used without restrictions* is the "go ahead" for industry. You can now rate PERFORMANCE over AVAILABILITY when choosing materials. By using copper and its alloys, brass and bronze, your product is easier to fabricate, better and more durable.

We can get more copper than we now have. Although industry and government have been consuming more copper than in any previous peacetime period, production has kept pace with this increased demand. And producers are not working at full capacity!

More copper keeps on coming. Eleven major new projects in the U. S. will start producing in the next 3 years. These mines will add 250,000 tons to our annual production—more than *¼ of all the domestic copper mined during 1953*. In addition, recent improvements in mining techniques now make it possible to obtain copper from ores considered commercially unworkable in the past.

Copper is virtually indestructible. At least 3 out of every 4 pounds of copper used in today's products, when scrapped, can be re-used in the future. Every day we are adding to our "copper capital". The more copper we use . . . the more we have!

Copper or its alloys provide these advantages . . .

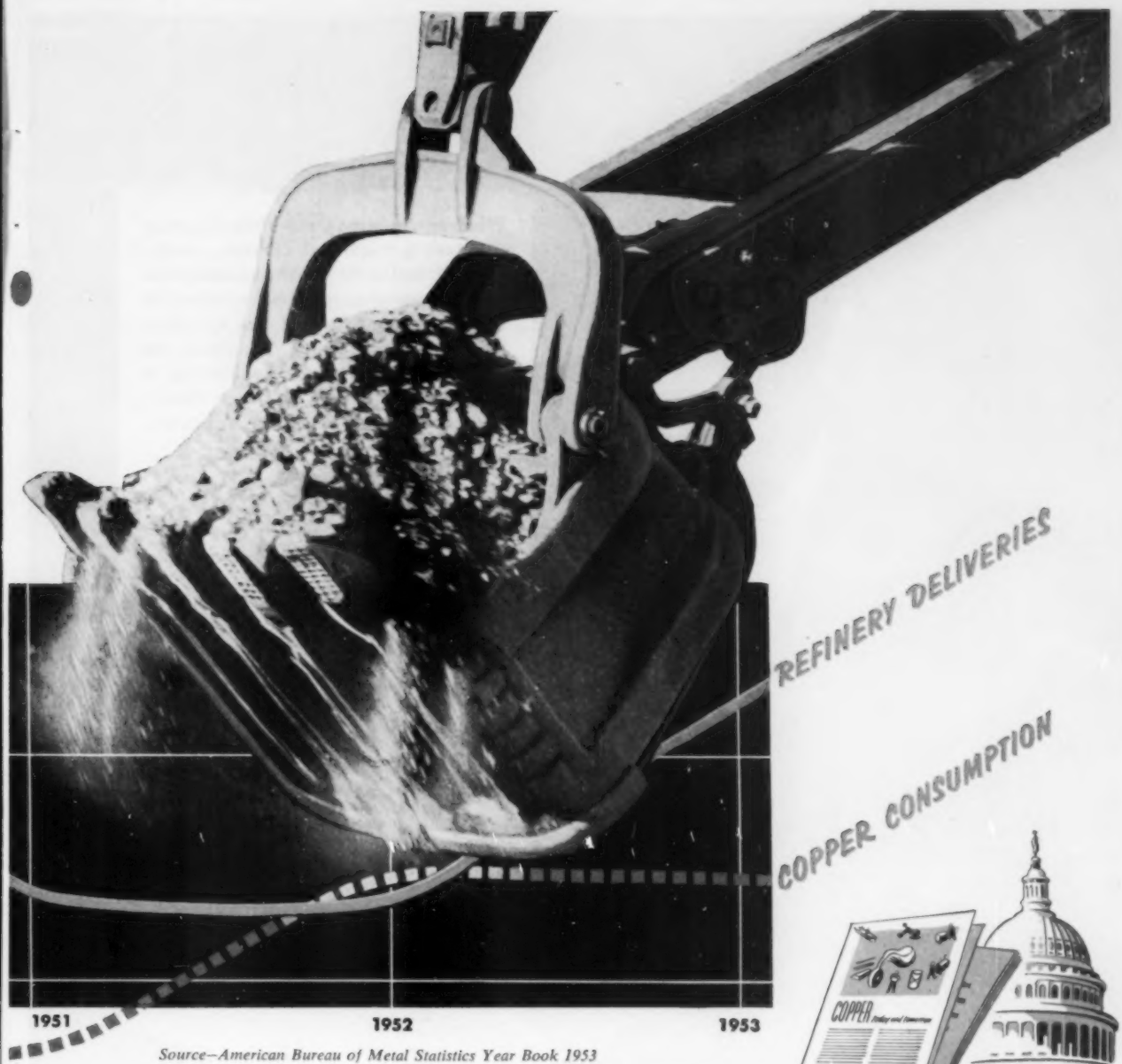
Best conductor of electricity commercially available.

Does not rust . . . high corrosion resistance.

Best heat transfer agent of all commercial metals.

Easy to machine, form, draw, stamp, polish, plate, etc.

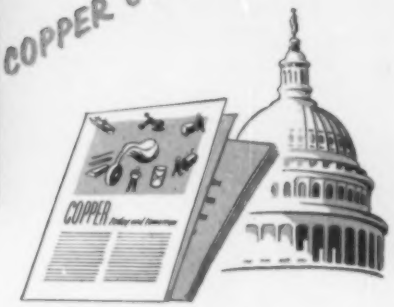
Welds readily . . . excellent for soldering and brazing.



Source—American Bureau of Metal Statistics Year Book 1953

Copper has a new ability to serve you. Many of your problems are being solved in the laboratories of the copper and brass industry. Whether it's a new alloy, a different temper or a special property . . . copper can help you develop new ideas. Copper can bring old methods up to date. Call a supplier of copper and brass and convert your thoughts to action!

COPPER & BRASS
Research Association



❊ ***"Copper . . . is fortunately available in ample supply to meet any foreseeable demand"***

Foreword, U. S. Dept. of Commerce
B.D.S.A. Copper Quarterly, August 1954

For information about U. S. copper supplies including free copies of this Government report and the new booklet, "Copper . . . Today and Tomorrow", send attached coupon to:

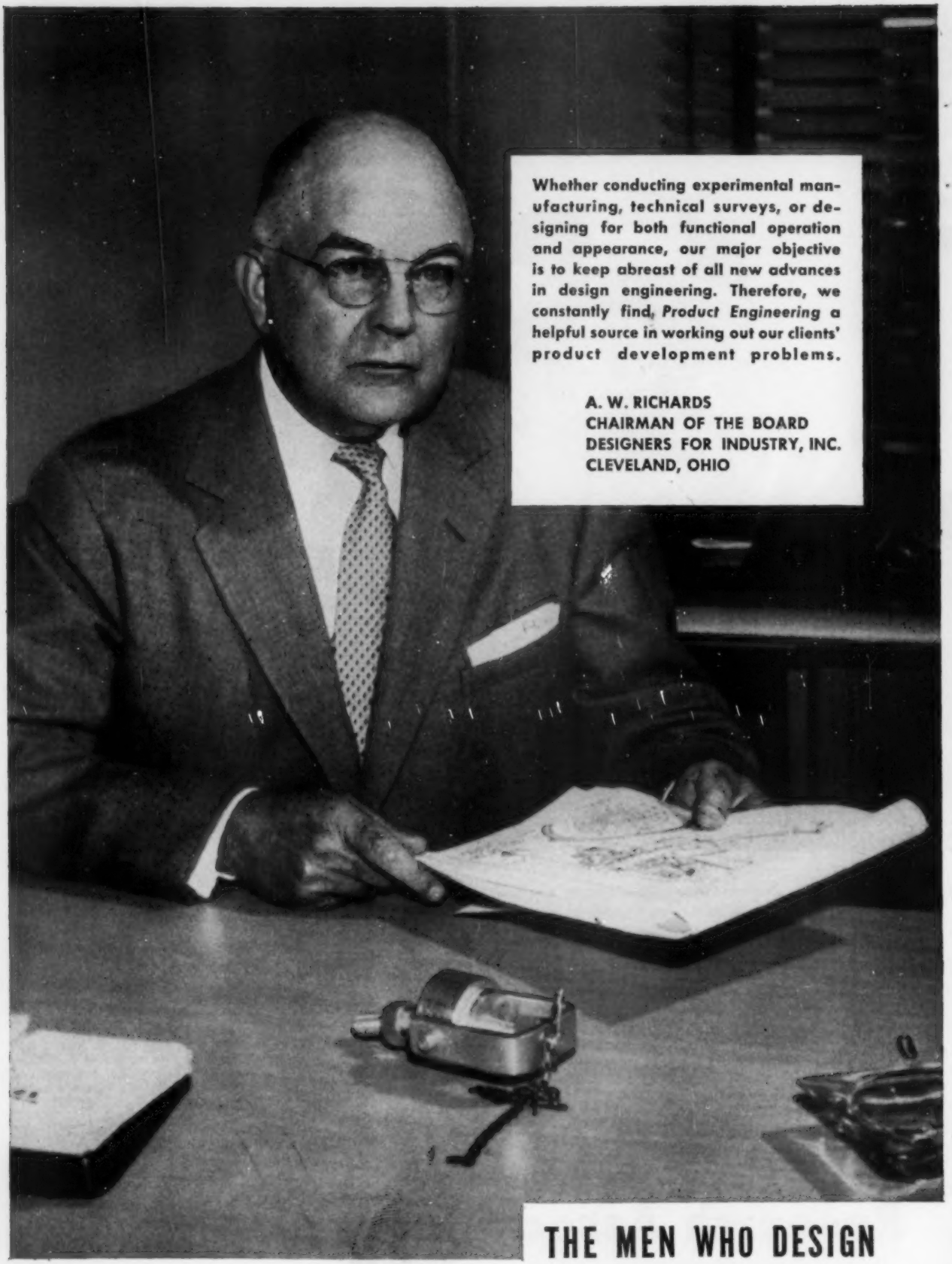
Copper & Brass Research Assn., Dpt. Q
420 Lexington Ave., New York 17, N. Y.

NAME .....

COMPANY .....

ADDRESS .....

CITY ..... STATE .....



Whether conducting experimental manufacturing, technical surveys, or designing for both functional operation and appearance, our major objective is to keep abreast of all new advances in design engineering. Therefore, we constantly find, *Product Engineering* a helpful source in working out our clients' product development problems.

A. W. RICHARDS
CHAIRMAN OF THE BOARD
DESIGNERS FOR INDUSTRY, INC.
CLEVELAND, OHIO

THE MEN WHO DESIGN

He Leads Designers for Industry

HE READS PRODUCT ENGINEERING

. . . and over 28,000* top design engineers constantly look for and find new design ideas in PRODUCT ENGINEERING. Isn't it just good practice to consistently keep your products before them by advertising in PRODUCT ENGINEERING?

Of course it is—because these 28,000* design engineers select and decide whose products to specify. They select by type and make the many materials, parts, and components that go into new machinery and equipment. They constantly seek new money-saving, labor-saving ways to make already fine products still better. And the balanced, informative and far-ranging editorial pages of *Product Engineering* help them do just this.

That's why design engineers subscribe to *Product Engineering* in record numbers. That's why they *route* it to other interested men throughout the Design Engineering Headquarters in which they work. That's why *Product Engineering* has become the preferred information source of men with the buying authority in the huge, ever-changing, $28-billion Original Equipment Market.

Consider, also, *Product Engineering's* acceptance among advertisers. In 1953, this magazine was entrusted with 1,044 *more* advertising pages than *any other design publication*—a huge lead, a sound testimonial of its sales power. And more and more advertisers are *concentrating* their advertising in *Product Engineering* for qualified specifiers of Original Equipment to read. But get the whole story—send for "Blueprint for Selling Industry's Blue-Chip Market" today.

**Subject to ABC audit. ABC net paid, December 1953 was 26,107*

The McGraw-Hill Magazine
of Design Engineering
McGraw-Hill Building, New York 36

DISTRICT OFFICES: Atlanta 3 – Boston 16 – Chicago 11
Cincinnati 8 – Cleveland 15 – Dallas 1 – Detroit 26
Los Angeles 17 – New York 36 – Philadelphia 3
Pittsburgh 22 – San Francisco 4

ABP ABC

AMERICA'S NEW PRODUCTS READ PRODUCT ENGINEERING

Designer's

These G-E aids help you design new TRI 55 CLAD motors into your machines

REG. U.S. PAT. OFF.

Making the New TRI CLAD Motor
A Part of Your Product
A SUMMARY OF THE NEW LINE OF A-C MOTORS, 1 TO 40 HP, AVAILABLE TO MACHINERY MANUFACTURERS
TRI CLAD
THE LEADER IN MODERN MOTOR DESIGN
EQUIPPED WITH
GENERAL ELECTRIC
MOTOR

SIMPLIFY MODERNIZATION of your machines with the new Tri/Clad '55' motor. A new bulletin, "Making the New Tri/Clad '55' Motor a Part of Your Product," will help in selecting the right motor for your application. It is designed to answer the questions you ask most frequently when buying motors. For your copy, check the coupon. Other aids for machine designers are described at right.

SPACE SAVINGS with the new Tri-Clad '55' motors can be read directly from this handy wallet-size slide rule. It determines ten dimensions instantly for any frame number. For yours, check coupon.

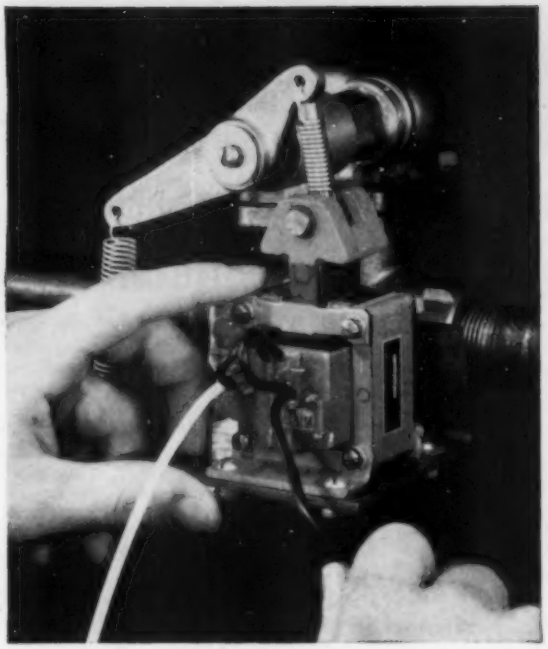
WEIGHT SAVINGS are significant with the new motors, and this slide rule tells you exactly how many pounds for each hp rating, for enclosed and dripproof motors, from 900 to 3600 rpm. Check coupon.

BUYER PREFERENCE for G-E motors is 2 to 1 in an independent survey, and you can take advantage of this when you tag your equipment with this card, available through G-E Apparatus Sales representatives.

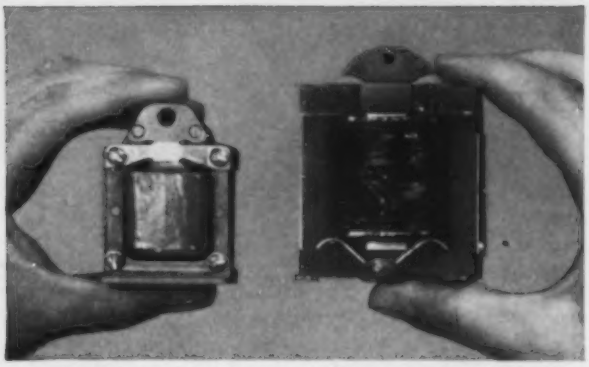
GENERAL ELECTRIC

Digest

PRODUCT HIGHLIGHTS

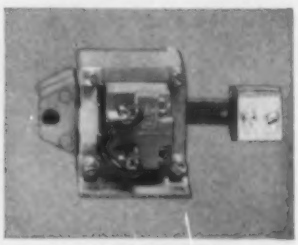


AC PULL FORM



COMPARISON OF NEW SMALLER SOLENOID WITH OLDER MODEL

DC PULL FORM



AC PUSH FORM

New industrial solenoids announced by G.E. smaller—more flexible—longer life

Twenty-two percent reduction in size for same power ratings is made possible in the new line of General Electric industrial solenoids by newly designed components. This means a saving of space in your machines, smaller enclosure, and reduced material costs.

Complete rating coverage is supplied by nine separate sizes. All sizes are available in push or pull forms, 25 to 60 cycle a-c, and d-c. Nominal ratings at maximum stroke are: 1" pull—1.4 to 36 pounds; ½" pull—3.0 to 40 pounds; ½" push—2.0 to 33 pounds; 1" push—4.3 to 28 pounds.

Versatile and compact, new G-E solenoids can be mounted in five positions—brackets can be moved to any of four sides, or thru-bolts can be used. To simplify wiring, leads and built-in terminal board are furnished on all strongbox coils.

Long life results from design features such as strongbox coil and double-strength spring-steel mounting brackets. General Electric laboratory tests have proved these solenoids to have much longer life.

For more information, contact your nearest G-E Apparatus Sales Office or Distributor, or check the coupon for Bulletin GEA-6215.

General Electric Co., Apparatus Sales Division, Sec. A668-116, Schenectady 5, N. Y.

Please send me the following bulletins: ✓ for reference X for immediate project

- ☐ GEA-6215 New Industrial Solenoids
- ☐ GEN-106 Slide Rule for space savings with Tri/Clad '55' Motors
- ☐ GEN-100 Slide rule for weight savings with Tri/Clad '55' Motors
- ☐ GEA-6200 Making Tri/Clad '55' Motors Part of Your Product

CONSULT YOUR SWEET'S PRODUCT DESIGN FILE. You'll find everything electric for machinery manufacturers in the General Electric section.

NAME..... COMPANY.....

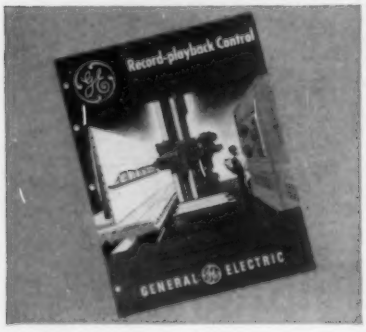
CITY..... STATE.....

TURN PAGE FOR MORE G-E PRODUCT HIGHLIGHTS

Two steps toward more automatic machine operation

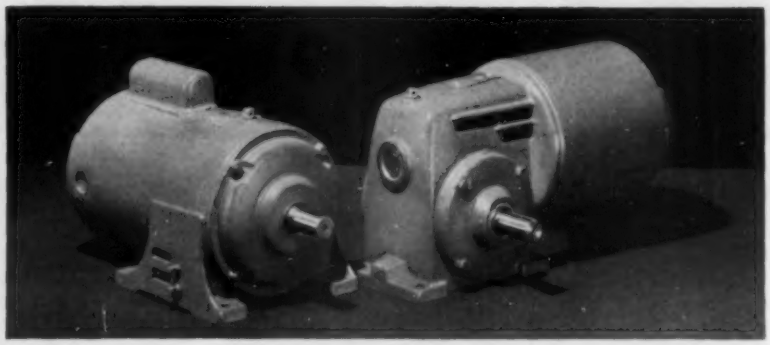
ALL ELECTRIC, this custom-engineered General Electric tracer control system provides automatic control of one or more machine motions.

Bulletin GEA-6122 explains, through the use of diagrams, the operation and components of the basic tracer control and its many variations. It is designed for fast, accurate production on milling machines, vertical boring mills, and lathes, and automatically follows templates, controlling feed motions.



RECORDING MOTION on a reel of magnetic tape, G-E record-playback control stores a record of all the operations needed to produce a part. This bulletin, GEA-6092, describes how the tape can be played back for automatic programming of production machines and processes. It shows how to get faster production at lower cost.

These two bulletins will be of particular interest to designers of general-purpose machine tools where a memory of complicated motion or sequences or a large number of operations is required. Send for your copies now.



New G-E fhp gear-motors are compact, light-weight, 'packaged' drive units

General Electric's revolutionary smaller, lighter fractional-hp motor design is now incorporated in gear-motors for the first time. With its highly efficient low-speed gears, you'll find this new gear-motor ideal for your applications.

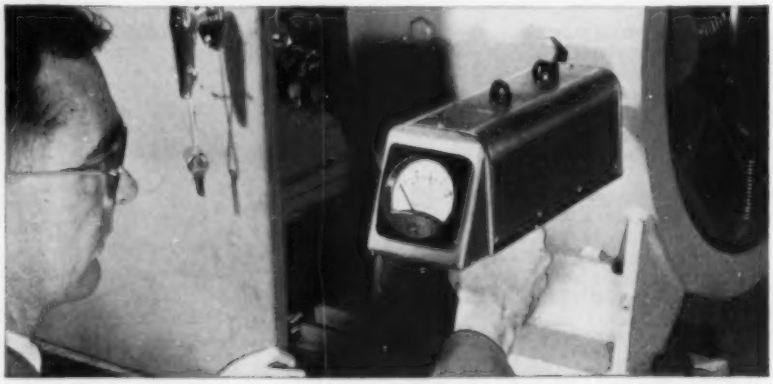
You save in ordering. Selecting single-package gear-motors the G-E way saves time. You can get off-the-shelf delivery on 56 popular-rated models. **You save on installation.** Unit construction of G-E gear-motors means they can be installed in a fraction of the time required for more complex systems. ***You save on space.*** They are compactly designed to help you put low-speed power in tight spots.

Features of the new gear-motors include greatly improved insulation that better resists unfavorable conditions, advanced-design ventilation, plus skillful use of new materials for better performance and durability. These give longer life to your machines. Ask for Bulletin GEA-6133.

G-E portable vibration meter cuts rejects by direct reading of acceleration and vibration displacement

Small, light, and self-contained, this highly sensitive vibration meter is battery operated. It measures displacement and acceleration over a frequency range of 10 to 250 cycles per second. It will measure from 3 to 300 mils peak-to-peak displacement and 0.03 to 10G peak.

Scales can be changed during operation, if operated in temperatures up to 130 F, and is not affected by magnetic fields of generators. For more information, ask for Bulletin GEC-1247.



GENERAL ELECTRIC

Designer's Digest

PRODUCT HIGHLIGHTS

Single-point adjustment of New General Electric d-c magnet brake simplifies installation

Built to AISE standards, new brake has these features

1 MANUAL-RELEASE MECHANISM. This feature provides accurate control of the compression-type spring, and permits removal of wheel or replacement of brake linings without readjusting torque setting.

2 ARMATURE GAP INDICATOR. Records changes in armature gap due to brake lining wear. An easily visible indicator shows when to adjust for lining wear.

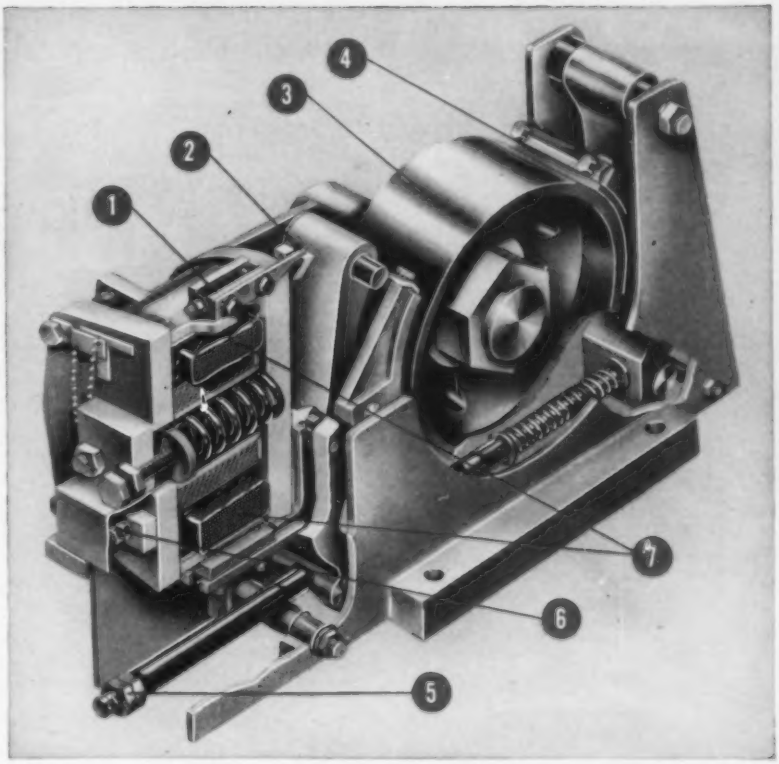
3 VENTILATED WHEEL OF MOLYBDENUM ALLOY. Designed for high tensile strength and excellent wearing characteristics.

4 REMOVABLE LININGS. No need to remove entire shoe assembly to replace lining. Release brake, using manual release, remove holding nuts which position the shoe lining and keep it firmly in place, then slip lining out.

5 SINGLE-POINT ADJUSTMENT. One simple adjustment for lining speeds maintenance. Only a wrench is needed to adjust magnet gap. Equal shoe clearance is obtained automatically. No trial-and-error adjustment—this new brake is designed to be self-centering.

6 TERMINAL STUD CONNECTIONS, Speeds wiring—protects magnet leads from strain.

7 "STRONGBOX" MAGNET COIL. Dust, moisture and oil are sealed out. Coil windings are impregnated with clear, solventless varnish drawn in under vacuum, to help protect from mechanical damage.



No need to keep both ends of General-Electric's new d-c magnet motor brake clear for servicing—all power connections, torque settings and shoe adjustments are located at one end. This means the G-E brake can be mounted in comparatively inaccessible locations since only the adjusting end of the brake has to be clear. The brake is built to AISE standards and is suitable for both horizontal and vertical mounting. It can be either left- or right-hand mounted with no change in pins or bolts required. Centerline marks simplify horizontal and vertical alignment of the brake with the motor shaft.

In addition to extensive laboratory tests, the brakes were installed and tested in actual on-the-job applications with the co-operation of four large industrial companies. The two-shoe, single-magnet brake established high standards for brake performance and maintenance on applications where continuity of service and low operating costs were of first importance.

Type IC9528 shunt-wound brakes will operate on 80% voltage. IC9528 series-wound brakes will release on 40% of rated current of the motor with which it is used, and will remain released until the current falls below 10 per cent of rated motor current. Check coupon for Bulletin GEA-6214.

General Electric Co.,
Apparatus Sales Div., Sec. A668-117
Schenectady 5, N. Y.

Please send me the following bulletins:

√ for reference
× for immediate project

- ☐ GEA-6214 D-c Magnetic Brakes
- ☐ GEA-6122 Tracer Control
- ☐ GEA-6133 Fhp Gear-Motors
- ☐ GEA-6092 Record-Playback
- ☐ GEC-1247 Vibration Meter

CONSULT YOUR SWEET'S PRODUCT DESIGN FILE! You'll find everything electric for machinery manufacturers in the General Electric Section.

NAME_____

COMPANY_____

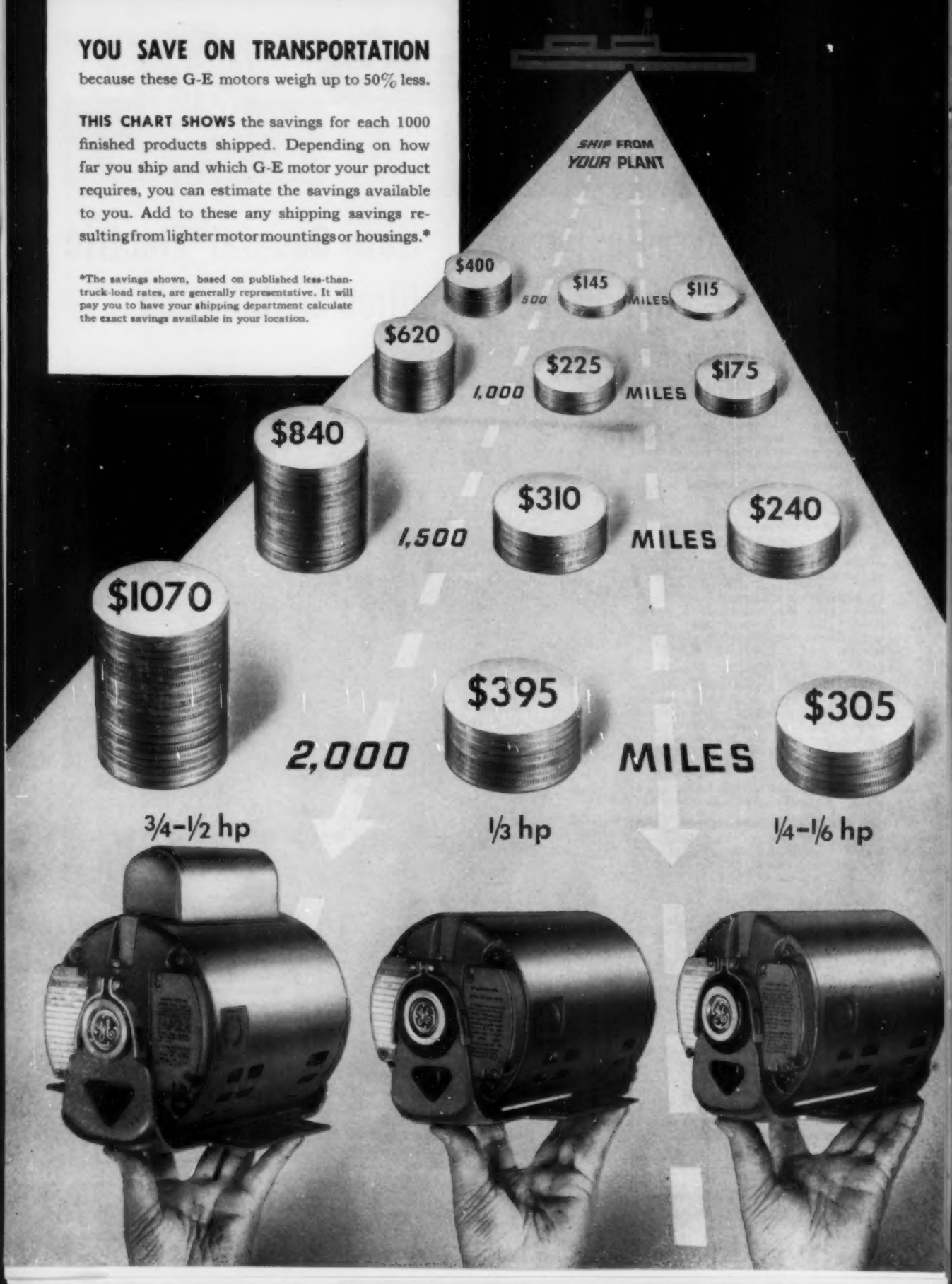
CITY_____ STATE_____

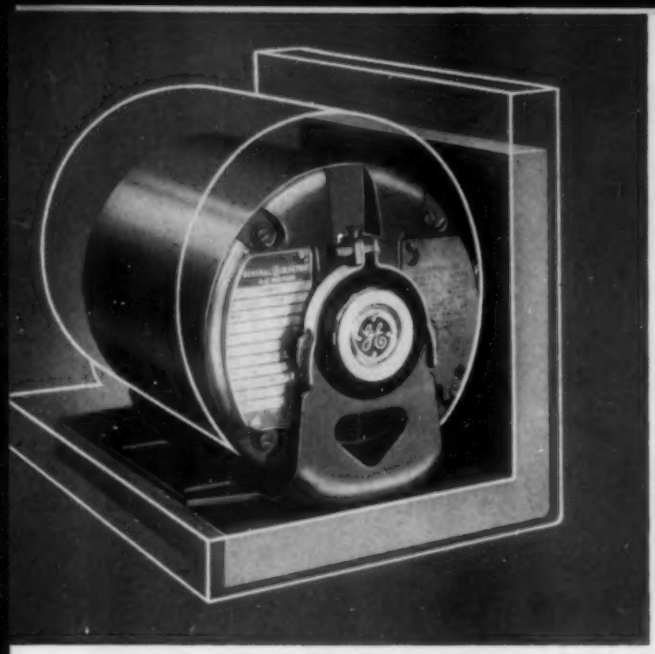
YOU SAVE ON TRANSPORTATION

because these G-E motors weigh up to 50% less.

THIS CHART SHOWS the savings for each 1000 finished products shipped. Depending on how far you ship and which G-E motor your product requires, you can estimate the savings available to you. Add to these any shipping savings resulting from lighter motor mountings or housings.*

*The savings shown, based on published less-than-truck-load rates, are generally representative. It will pay you to have your shipping department calculate the exact savings available in your location.





YOU SAVE ON MATERIAL COSTS because new G-E motors—as much as 50 percent lighter, 40 percent smaller—permit you to design smaller and lighter motor mountings and housings.

YOU SAVE ON ASSEMBLY COSTS because your assembly-line personnel will produce more efficiently with less fatigue since these General Electric motors are far easier to handle.

New smaller, lighter G-E motors give you 3 important cost savings

Significant savings are yours when you specify new lighter, smaller General Electric fractional-horsepower motors to power your products:

1. **YOU SAVE ON TRANSPORTATION**—New G-E motors, as much as 50% lighter, reduce your finished-product shipping costs.
2. **YOU SAVE ON MATERIALS**—Reduced motor weight permits use of lighter mountings. Smaller size (by 40%) means smaller housings are adequate.
3. **YOU SAVE ON ASSEMBLY**—Your assembly-line people will find the all-new G-E designs take the strain out of motor handling, speed installation.

You'll find these new G-E motors solve design problems, too: improved insulation and a new ventilation system permit application where adverse conditions exist . . . add to motor life in any location. A better lubrication system and thrust-bearing design mean that these new motors will operate at any angle.

To start saving with these amazing new motors, contact your nearby G-E Apparatus Sales Office today. Or write for Bulletin GEA-5567 to General Electric Co., Section 702-10, Schenectady 5, New York.

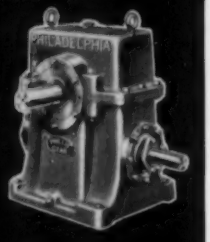
GENERAL ELECTRIC

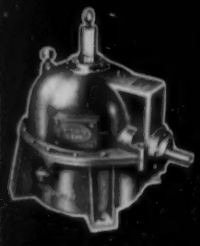
PHILLIE GEAR ...makes all types of REDUCERS

...here's why:

Vertical MotoReducer

Steeple Type Worm

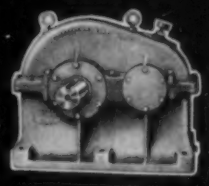

Right Angle Worm

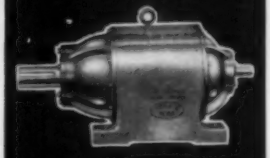

Cooling Tower Drive

GearMotor

Years ago, we found that many firms preferred to buy all their Speed Reducers from "one manufacturer," because they could then make that "one source" of supply entirely responsible for performance and service. We also soon realized that no one or two types of Reducers were a "panacea" for all requirements,—so that is why we designed and manufacture every type of Reducer: Worm, Herringbone, Spiral-Bevel, Helical, Planetary, MotoReducers, and GearMotors . . . . all for a wide range of Horsepowers and Reduction Ratios.

The illustrations herewith show the wide variety of Speed Reducers available from "Phillie Gear" . . . . Catalogs are available describing each type.


Herringbone Reducer

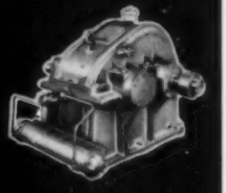

Planetary Reducer

Spiral Bevel Helical & Herringbone

MotoReducer with "Planetorque" attachment

Change Speed Unit

Vertical Worm


High Speed Reducer or Increaser

Philadelphia Gear Works, INC.

ERIE AVE. AND G ST., PHILADELPHIA 34, PA.

NEW YORK • PITTSBURGH • CHICAGO • HOUSTON • LYNCHBURG, VA.

Industrial Gears and Speed Reducers
LimiTorque Valve Controls

Perspectives

DESIGN AND DEVELOPMENT

A NEW LAW A NEW BUSINESS

For the first time, private industry will be able to enter the race to develop atomic power on a competitive basis . . . Democratic filibusters not withstanding. Until Congress rewrote the 1946 McMahon Act, industry had been kept in the role of a government agent in all but the fringe areas of nuclear power research and development. The government monopoly has not collapsed under the new law, but it is relaxed enough to let private enterprise get in the costly race.

TIGHT CONTROL

Even so, tight federal regulations and controls face those firms who plan to get into the nuclear power field in any capacity. An electric utility, for example, planning for eventual construction and operation of a nuclear fuel generating plant, will be required to get at least seven separate government licenses and permits before they can legally operate. Moreover, a design engineer employed on one of these projects will have to get security clearance under the Civil Service Commission or FBI procedures if he needs access to restricted technical information held by the Atomic Energy Commission. The operator of a power plant will need both a security clearance and an operators license. All in all—despite its many advantages—under the new law, the atomic power industry will be the most regulated industry in the economy.

That's true even under the general ground rules set down by the law. The AEC, which becomes the regulatory body for the new industry, still has to draw up the fine print rules. Promulgating these regulations is the next big step before the first license or permit can be issued under law. The hearings and discussions involved in fixing the rules will probably take six months to a year. AEC will have to work full speed if it expects to issue a license by the end of 1955.

THE FINE POINTS

In spite of the stringent controls, the new law still represents significant gains for private industry. Research is encouraged . . . development is permitted . . . construction and operation of nuclear power plants are possible. Private concerns may use and produce nuclear material in its own facilities, although the title for all such material remains with the federal government. Up to now, this had been prohibited. Under a license a private firm may conduct research in the nuclear power field using the nuclear materials free or for a nominal charge by the AEC. Formerly, such research was only permitted under AEC contract. Now, a private firm may develop, construct, operate, and own the facilities. Under the old law, this was specifically prohibited. Also, a person may patent non-weapon inventions in the nuclear field, although the basic patents are

(Continued on page 125)

THIS FLEXON *"Instrument Quality"* BELLOWS . . .

. . . is the heart of this FISCHER & PORTER receiver

In a device such as the Fischer & Porter Ratographic Indicator illustrated above, the sensitive and powerful bellows-spring assembly is the heart of the instrument. To assure accurate, dependable performance of these units, FLEXON "Instrument Quality" Bellows are used.

FLEXON "I-Q" Bellows are manufactured to exacting standards to assure essential linearity characteristics, plus closely held effective area tolerances and uniform spring rate to obtain the high degree of accuracy needed in modern process control instrumentation. By using FLEXON "I-Q" Bellows, Fischer & Porter Co. is able to offer pneumatic receivers accurate to ½ of 1% with negligible deadspot and hysteresis.

If accuracy, dependability and long life are important in your product, it will pay you to specify FLEXON "Instrument Quality" Bellows. For specific recommendations, just send an outline of your requirements.

ASK FOR THIS BELLOWS DESIGN GUIDE

The new Flexon Bellows Design Guide gives full specifications and application data for Flexon Bellows. Write for your copy, today. There is no obligation.

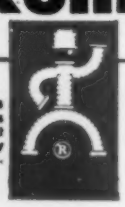
See us at the Instrument Show in Philadelphia — Booth 650-652

Flexonics Corporation

FLEXON BELLOWS DIVISION
1351 S. THIRD AVENUE • MAYWOOD, ILLINOIS

FORMERLY CHICAGO METAL HOSE CORPORATION
In Canada: Flexonics Corporation of Canada, Ltd., Brampton, Ontario

Flexon identifies products of Flexonics Corporation that have served industry for over 52 years.



Flexible metal hose

Expansion joints

Aircraft components

Metallic bellows

subject to compulsory license during the next five years. Before, all the patents automatically became the property of the federal government. Finally, manufacturers may now build for export either power or experimental reactors under AEC licenses and international agreements.

HOW MANY TAKERS

During the hearings last summer and earlier this year no person or firm indicated intentions to apply for any license or permit in the immediate future. But by the time the AEC rule book is out, there should be a few applicants ready. To date, a group headed by Dow Chemical and Detroit Edison looks like it might become the first applicant for the construction and operation of an actual power plant. That group is already well advanced toward a mock-up of a fast breeder nuclear plant which would produce both power and plutonium for atomic bombs. Two other firms, North American Aviation, Inc. and American Machine & Foundry, have offered to build experimental reactors for any firm that can qualify.

WHY THE CHANGE

In 1946 when the McMahon Bill became a law, the United States alone had had the facilities to produce nuclear weapons. The monopoly was broken by Russia in 1949 when their first A-bomb was exploded, and again in 1953 with a series of H-bomb explosions.

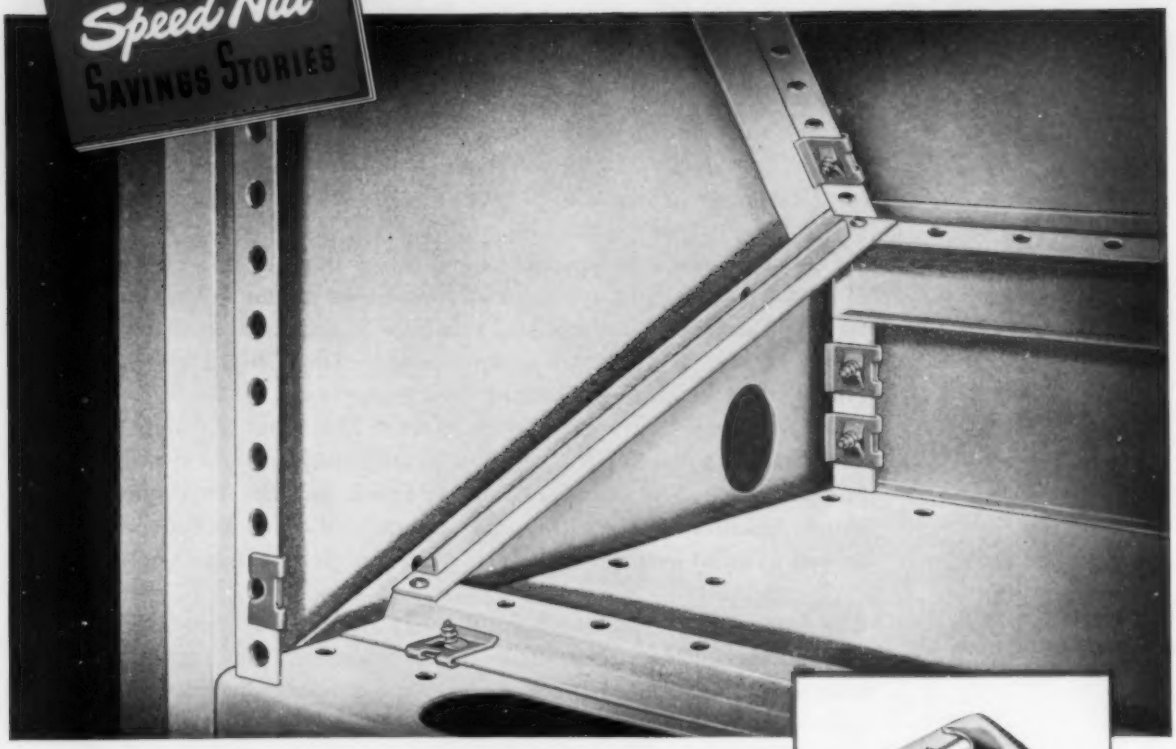
In the present cold war atmosphere, leadership in the peaceful use of atomic power becomes as important as the superiority of A-bombs during an all out war. The use of the peacetime atom has become such a force in the propaganda war between the East and West that one top U. S. official has warned: "It would be very damaging to the position of the United States if another country were to be the first in the peacetime application of the atom. And it would be especially damaging if the Soviet Union happened to be that country. If this were to happen, they could point to this as proof of their propaganda line that the United States is interested in Atomic energy only for destructive purposes, while the Soviet Union is interested only for peaceful purposes."

LITERATURE FOR THOSE INTERESTED

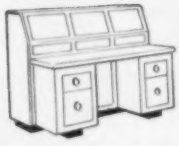
There is no doubt that the passage of the new law will stimulate interest in the technology of nuclear power plants. Since most of the literature on this subject is still stamped "restricted" by the AEC, security clearances are necessary for anyone wanting to read it. This, of course, means more personnel investigations by government agencies. However, the new law makes all this somewhat easier by classifying the technical material in accordance with its importance to national security. By the same token, all personnel clearances will be in accordance with the class of material to which the person will have access. Under the previous law, everyone had to go through the same long-winded investigation no matter how small was his need for information held by the AEC. But by the end of the year AEC figures that private concerns will have invested $8-million in surveying reactor technology and making preliminary designs.

FASTEST THING IN FASTENINGS®

TINNERMAN Speed Nut® SAVINGS STORIES



SPEED NUTS® "build in" 30% savings on enclosure system

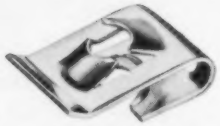


● Here's how the Elgin Metalformers Corporation, Elgin, Illinois, reduced the total cost of its EMCOR control equipment enclosures by 30%!

The basic EMCOR console requires 276 mounting holes for various assembly arrangements. Formerly, each hole was tapped . . . tight tolerances and paint clogging presented a costly problem. Now, the use of 40 "J" Type SPEED NUTS makes it unnecessary to tap the holes. SPEED NUTS provide the right amount of float, eliminate the problem of paint clogging, and furnish an attachment 3½ times stronger than the former fastening method. And they can be easily moved from hole to hole, wherever attachments are to be made.

In other applications, SPEED NUTS replaced 48 weld-type fasteners to help gain a substantial saving in assembly space as well as the over-all saving in production costs!

Ask your Tinnerman representative for data on better, more economical fastening methods for your own products!



"J" TYPE SPEED NUTS

These standard Tinnerman fasteners snap over panel edges by hand. They are self-retaining in center hole locations providing quick, easy fastenings even in blind assemblies. A full range of panel thicknesses and screw sizes are available to meet your particular requirements.

Write today for your "SPEED NUT Savings Stories" booklet of typical Tinnerman savings to industry: TINNERMAN PRODUCTS, INC., Box 6688, Dept. 12, Cleveland 1, Ohio.

In Canada: Dominion Fasteners Ltd., Hamilton, Ontario. *In Great Britain:* Simmonds Aerocessories, Limited, Treforest, Wales. *In France:* Aerocessoires Simmonds. S. A.— 7 rue Henri Barbusse, Levallois (Seine).

TINNERMAN Speed Nuts®

MORE THAN 8000 SHAPES AND SIZES

Plus to Minus and More

A REPORT on the general business situation in July 31 *Business Week* states that the big buying power of the country is found among consumers that are in the $5,000 plus income bracket. Presumably the greatest impetus to further business growth would be a new "consumer hard goods product." Just as TV stirred business, so would another new consumer hard goods product at this time give business a tremendous lift.

Unfortunately, there is no great new product now visible on the horizon. And it requires from five to ten years for a new product to travel from the horizon to the distributors and retailers. There is little hope that there will be placed on the market in the near future a brand new hard goods consumer product that will render a service that is not available at this time. Such wishful thinking is wasted effort.

Too many people are always searching for acres of diamonds that they can dig with a rented power shovel and an hourly paid operator. Because of impatience, greed, lack of vision or other shortcoming, they can't see the profit in picking up diamonds one at a time, even if they were of Kohinoor size. And if it happens that these diamonds are in their own back yard, they disdain paying any attention to them. They simply believe that if the diamond were genuine it would have sense enough not to be in the back yard. They just don't realize that diamonds in a setting of golden opportunities are no respecters of places or persons. In the "backyards" of industries lie the solution to the problem of creating bigger markets.

The *Business Week* report includes the statement that the big volume of buying is found in the $5,000 plus income bracket. That bracket is not large enough to support the kind of economy this country must have. To make the market bigger the $5,000 plus must be changed to an appreciably smaller figure, such as $5,000 minus. This can be done only by reducing costs and prices, and more engineering design can accomplish that.

Industry today is passing over a threshold into the greatest era it has seen since Henry Ford forced the wide adoption of mass production techniques. The ground work has all been laid. Electrical and electronic components, computers, servos, hydraulic and pneumatic units and a vast new field of technology are hungrily knocking at the doors of industry, begging to be put to work. We are beginning the age of automatic mass production.

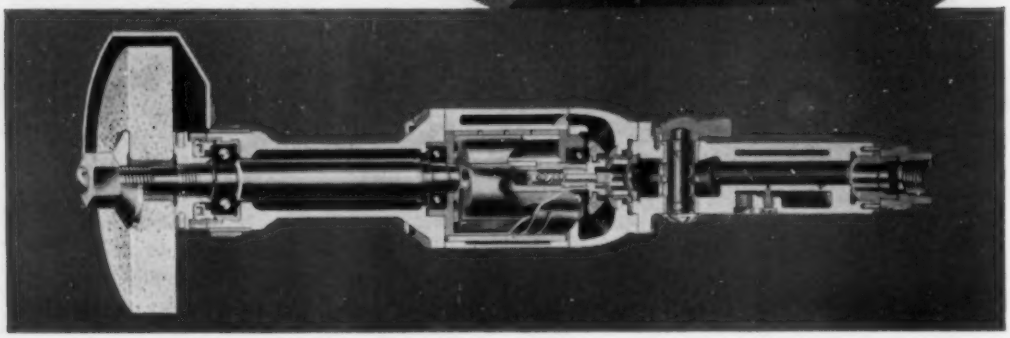
Automatic production machinery will have to be designed. Products will have to be redesigned not only to obsolete old models but also to have maximum productibility by automatic machines and production lines. More and better engineering brains, more engineering man hours, more research and testing will be needed to accomplish all this. A big plus on all these items will make a comparable big minus after the $5,000 figure, and that will mean more for everybody. The products that are sold today to the $5,000 plus income bracket will be reduced in price for salability to the much larger income bracket that starts at some $5,000 minus figure. And the bigger the minus the bigger the market.

George F. Foderaro

With New Departures—

ROTOR GIVES UPKEEP THE "AIR"!

Rotor Tool Company design utilizes three New Departure **ball** bearings. Front bearing is wider to give greater surface on shaft and housing to withstand vibratory loads.



Holding the line against maintenance downtime! Three New Departures in the Rotor Tool air grinder need no adjustment . . . cut lubrication requirements to virtually zero.

These New Departure double-shielded bearings are protected from foreign matter. They have the high capacity to carry radial and thrust loads . . . to withstand the shocks of hard use and rough handling. At the same time, cool-running New Departure **ball** bearings maintain accurate alignment and assure maximum power at the grinding wheel.

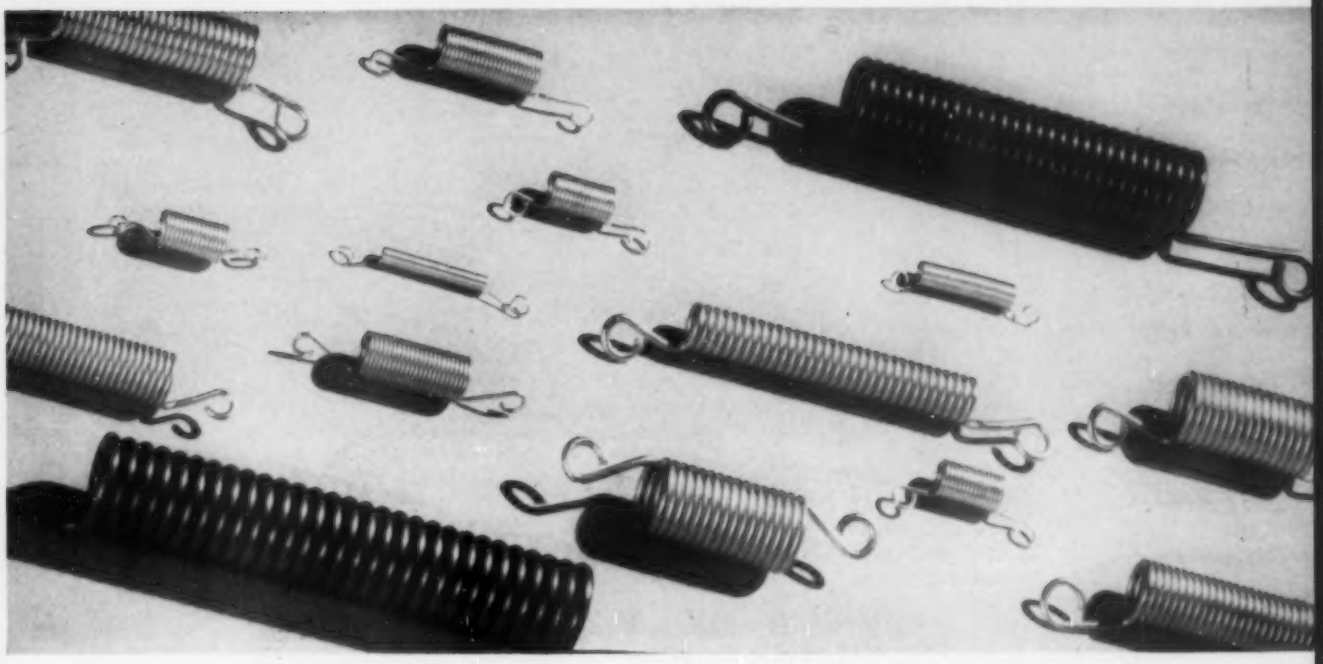
You can build these advantages into *your* product, too. Talk with your New Departure engineer—*today!*

NEW DEPARTURE

BALL BEARINGS

NEW DEPARTURE • DIVISION OF GENERAL MOTORS • BRISTOL, CONNECTICUT
Plants also in Meriden, Connecticut, and Sandusky, Ohio
In Canada: McKinnon Industries, Ltd., St. Catharines, Ontario

Constant Force Compression Springs



EDWIN H. BOERNER, HUNTER SPRING COMPANY

ALTHOUGH INTENDED primarily for constant-force applications, the springs shown above can be designed to have a force that increases, decreases or remains constant with increasing deflection. In contrast to the neg'ator which is basically an extension member, Fig. 1(A), this new type, called Flex'ator, is essentially a compression spring. In Fig. 1(B), it is shown in two positions; before application of force P (left) and at a deflection F (right). As the load is applied, the loading points approach each other, the spring action being one of flexing rather than compressing or extending as in conventional types.

The line of force is parallel to the axis of the undeflected spring body but does not pass through the axis as in other helical springs. Deflection can be taken relative to any fixed point, but in this discussion, it will be considered as the change in vertical position of the center of the upper hook from rest.

The spring body is close-wound and formed ends are provided for application of force. As will be shown later, the length a and angle α of these arms are important parameters. The body length is given as dN, the product of wire diameter and number of

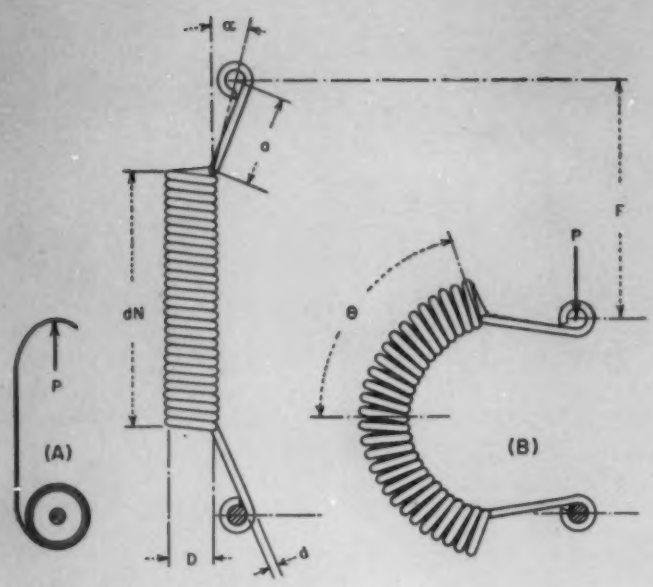


Fig. 1—Comparison of operation of neg'ator (A) and Flex'ator (B). Both are primarily intended for constant force service. Neg'ator is characterized by loading points that move away from each other; Flex'ator, by points moving toward each other with positive deflection.

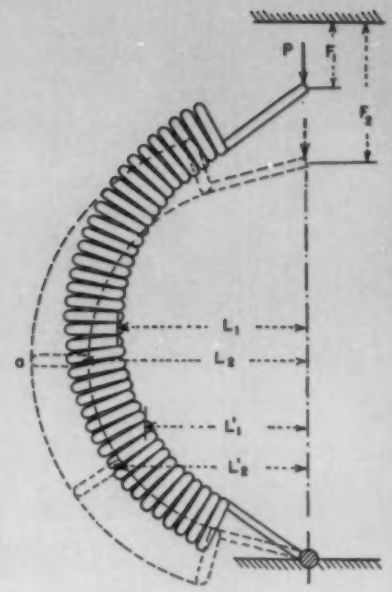


Fig. 2—Flex'ator shown in two deflected positions. Moment arm L varies with deflection as shown in contrast to constant moment arm for compression and tension springs.

New basic spring form can have positive, negative or zero gradients. With emphasis on zero gradient (constant force) applications, here are data on operating characteristics, force—deflection relationships, effects of design parameters on performance, and typical applications.

coils. Deflection can also be expressed by the angle θ between the planes of the center coil and an end coil.

With the lower hook in Fig. 1(B) held stationary but free to rotate, the spring body arches away from its original position and the line of force. Although a few degrees of each wire coil on the inside are squeezed together and do not open most of the coil opens as deflection increases. The opening between coils is greatest in the middle coils and is a maximum on the edges away from the line of force.

Pins or bearings of some kind are usually used in the hooks because of the change in orientation of the hook with deflection. There must be free movement between the hooks and external means of force application for minimum friction during deflection.

PERFORMANCE CHARACTERISTICS. In any extension or compression spring, the torsional shear stress at any cross section of an active coil is proportional to the force applied at the ends of the spring. Neglecting the effects of wire curvature, the maximum torsional shear stress in any cross section is in the outside fibers of the wire and is given as:

$$S = \left(\frac{8D}{\pi d^3}\right) P$$

Thus, the torsional shear stress is proportional to applied torque, the product of applied force and a moment arm equal to the mean coil radius.

Since the mean coil radius changes only slightly with deflection, stress in compression or extension springs can be considered as being proportional to either force or torque with little difference. But the difference is important in the operation of a Flex'ator. A controllable increase in moment arm with deflection produces the controllable gradient.

Two coils, one at the center of the body and one between the center and the lower end of the body, are shown in Fig. 2 as they would appear at the two deflections, F_1 and F_2. The moment arm of the force P applied to any coil is taken as the distance between the center of the wire on the inside of the coil and the line of action of P. Therefore, at deflection F_1 the center coil has a moment arm L_1 and the lower coil has a moment arm L'_1.

At either deflection the moment arm of the center coil (L_1 or L_2) is larger

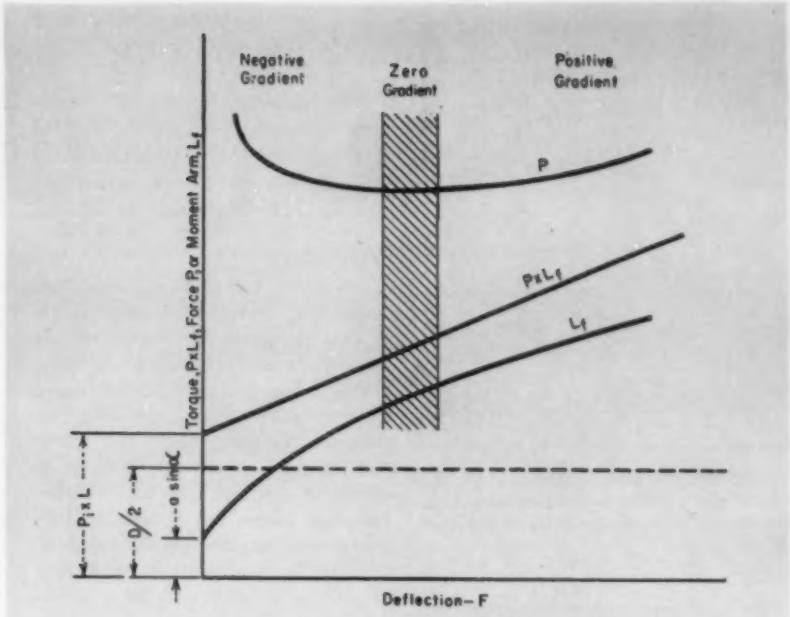


Fig. 3—Three different types of gradient are noted on force curve (top) which is obtained by dividing torque curve ($P \times L_f$) by moment arm curve (L_f). Area marked by section lines indicates range of deflections for which the spring is useful for constant-force duty.

SYMBOLS

- P — Applied force, lb.
- D — Mean coil dia., in.
- d — Wire dia., in.
- F — Deflection, in.
- P_i — Initial tension, lb.
- α — Arm angle, deg.
- a — Arm length, in.
- L — Moment arm of force P, in.
- N — No. of active coils
- θ_r — Body deflection angle, rad.
- θ_b — Body deflection angle, deg.
- G — Torsional modulus, psi

than that of all remaining coils in the spring, including L'_1 and L'_2. It is also apparent that the moment arm of each coil increases as deflection increases. Thus, the mean effective moment arm of all coils increases with deflection in contrast to the constant moment arm of compression and extension springs.

Maximum torsional shear stress occurs at the wire cross section "a" in Fig. 2. Since the force applied to all coils is equal and the moment arm decreases from the center to the ends of the spring body, the torque and shear stress decrease progressively from the center to the ends.

The variation of torque with deflection is shown by the middle curve of Fig. 3 for a typical spring. The bottom curve gives the mean effective moment arm (L_f) as a function of deflection for the particular spring characteristics that were chosen.

Dividing the curve for torque ($P \times L_f$) by the effective moment arm curve results in a curve of spring force as a function of deflection. The gradient of this force-deflection curve approaches zero to the same degree that the increase in moment arm compensates for the increase in torque; it is constant through any deflection for which the slope of the effective moment arm remains equal to that of the torque curve. For example, the shaded area of Fig. 3 shows the range of constant force for the given spring.

Depending upon the deflection range required, it is relatively easy to obtain a load variation of only three or four percent, which is within the limits normally established for a constant force device. Also, it is possible, as shown, in Fig. 3 to obtain either negative or positive gradients.

FORCE AND DEFLECTION EQUATIONS

The force (P) and deflection (F) at any body deflection angle (θ) is

$$P = \left[\frac{\theta_r G d^4}{8DN} + \frac{P_i D}{2} \right] \div \left[a \sin(\alpha + \theta_b) + \frac{dN}{2\theta_r} \left(\cos \frac{\theta_b}{2} - \cos \theta_b \right) \right] \quad (1)$$

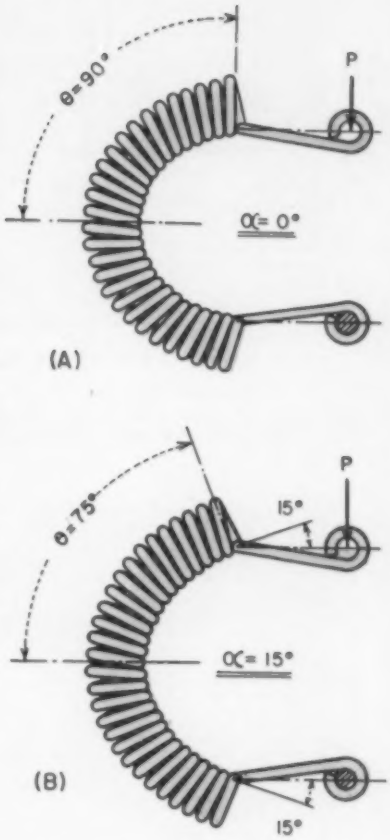


Fig. 4—Useful deflection range is limited by parallel-arm position illustrated above for two springs. In (A) deflection of spring body is 90 deg and $\alpha = 0$. With $\alpha = 15$ deg, body deflection is limited to 75 deg as represented in sketch (B).

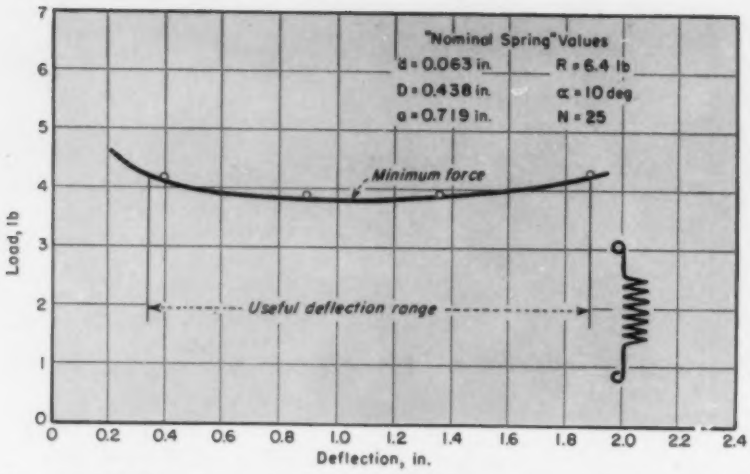


Fig. 5—Force-deflection curve for nominal spring depicted above emphasises that the device actually has a very low gradient and is not actually a constant-force unit. Because of sharp rise in force at low deflections, most springs will probably be designed in the middle, flatter range of deflection.

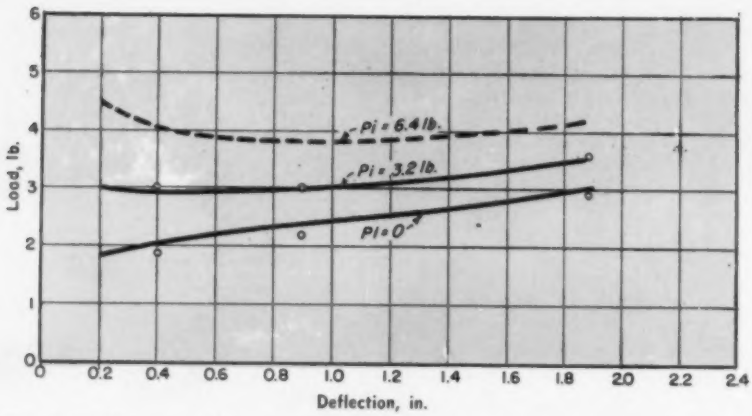


Fig. 6—To illustrate effects of varying initial tension, nominal spring of Fig. 5 is shown above for three values of P_i. To achieve a constant force-deflection characteristic the magnitude of initial tension should, in general, be as large as possible.

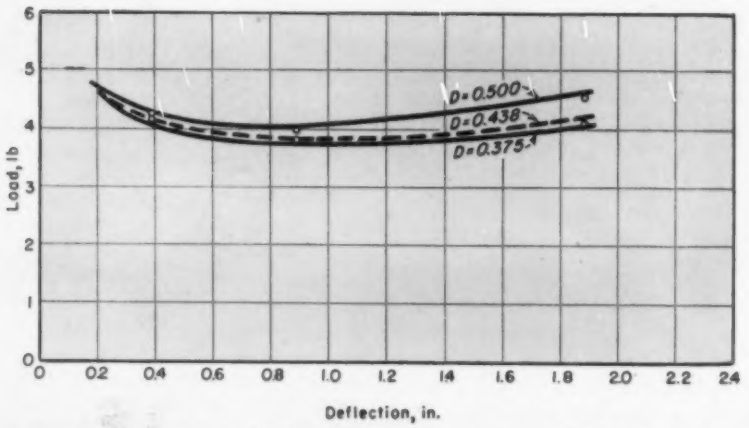


Fig. 7—Increasing the mean coil dia of the nominal spring of Fig. 5 (D = 0.438 in.) to 0.500 in. makes curve more concave. Decreasing D to 0.375 merely lowers the whole curve without changing its shape effectively.

$$F = 2a\,[\cos\alpha - \cos(\alpha + \theta_b)] + (d\,N)\left(1 - \frac{\sin\theta_b}{\theta_r}\right) \qquad (2)$$

The numerator of Eq (1) represents the applied torque ($P \times L_f$) the first term is directly proportional to θ_r and the second term to initial tension P_i. The denominator of Eq (1) gives the mean effective moment arm of all coils.

The two factors in Eq (2) represent, respectively, the portions of total deflection produced by inward motion of the arms and by flexing of the body.

Eqs (1) and (2) are not only more tedious to solve than equivalent expressions for compression and extension springs but also are difficult to analyze in terms of how each variable influences force and deflection characteristics. Thus, the effects of each of the six basic variables are treated graphically in Figs. 5-10 for a typical constant-force spring.

These curves show both test values (solid lines) and theoretical values (circled dots) calculated with Eqs (1) and (2). The largest deviation of a calculated point from a test curve is about eight per cent; most points are within three per cent. Therefore, although several basic approximations were necessary to derive the equations the results are within the accuracy normally required.

DEFLECTION RANGE. The range of deflection which can be used is an important consideration in selecting a particular design to fit application specifications. The maximum limit on deflection that seems to be practical for zero-gradient springs is that value of body deflection angle (θ) at which the two arms are parallel, as shown in Fig. 4.

Beyond the parallel-arm position, the first term in the denominator of Eq (1)—the portion of the mean effective moment arm contributed by the spring arms—decreases with deflection and tends to increase force. The rate of increase of force with deflection then becomes significantly greater.

When $\alpha = 0$, the parallel-arm position corresponds to a body deflection angle $\theta_a = 90$ deg. When the arm angle is greater than zero, such as $\alpha = 15$ deg. in Fig. 4, the parallel-arm position corresponds to a body deflection angle less than 90 deg. In general, the maximum body deflection

angle is simply $\theta_{max} = 90 - \alpha$. The parallel-arm position for each of the curves in Figs. 5-10 is represented by the circled dots at the extreme right.

Since less space is required at larger deflections, it is desirable to select the parallel-arm position as the maximum deflection limit, so long as the allowable force variation is not exceeded. The allowable force variation, assuming, as is usually the case, that the minimum deflection limit is in or below the middle range of the curve, is:

$$\Delta P = \frac{P_1 - P_{min} \times 100}{P_1 + P_{min}} \qquad (3)$$

where

P_1 = load corresponding to the parallel arm position.

The actual load variation for the spring in Fig. 5 is

$$P = \frac{4.20 - 3.75}{4.20 + 3.75} = \pm 5.67 \text{ per cent}$$

This value represents the total per cent load variation through a deflection range from the parallel-arm position to a small deflection value at which the force is equal to that of the parallel-arm position. With a force of 4.20 lb at the parallel-arm position in Fig. 5, the "useful deflection range" thus defined extends from $F = 0.34$ in. to $F = 1.88$ in. with $P = \pm 5.67$ per cent.

If minimum load variation is the primary objective, a smaller deflection range centered around the minimum force would produce a much lower value. Thus, in Fig. 5, a deflection range from $F = 0.8$ in. to $F = 1.2$ in. produces a load variation of only 0.65 per cent. In practice this particular spring would probably be uneconomical for such a small deflection range since so small a portion of its useful range is being used.

EFFECTS OF VARIABLES

From Eq (1), the spring force for a given material is a function of six variables:

P_i, D, N, α, a, and d

Using the nominal spring of Fig. 5, the curves of Figs. 6-10 show how each of the first five of these factors, in turn, affect its force-deflection characteristics. Of course, the magnitude of these variations is not identical for all springs, but the direction and type of change are generally applicable.

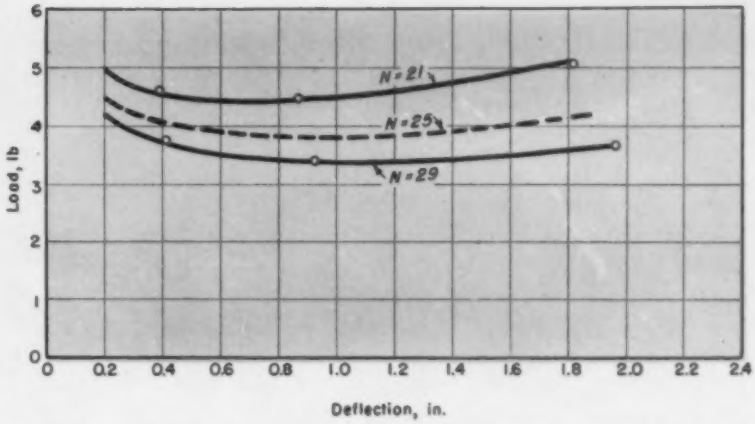


Fig. 8—Force deflection curve of Fig. 5 drops and tends to flatten when number of coils is increased. This effect lessens as the number of added coil increases.

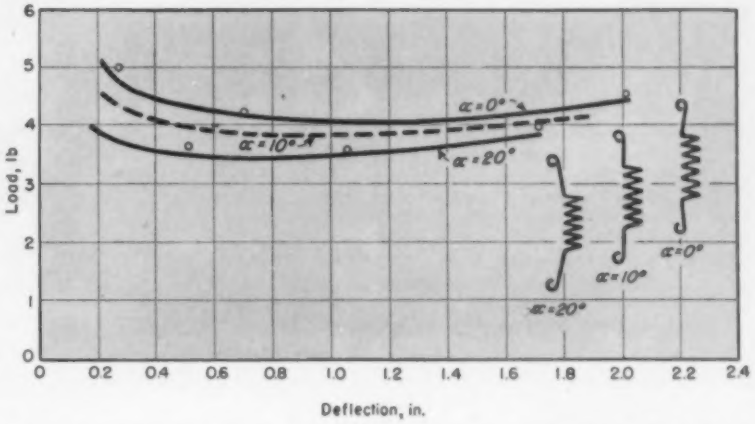


Fig. 9—Increasing the nominal arm angle from 10 to 20 deg reduces the force at all deflection values but does not appreciably change the shape of the curve.

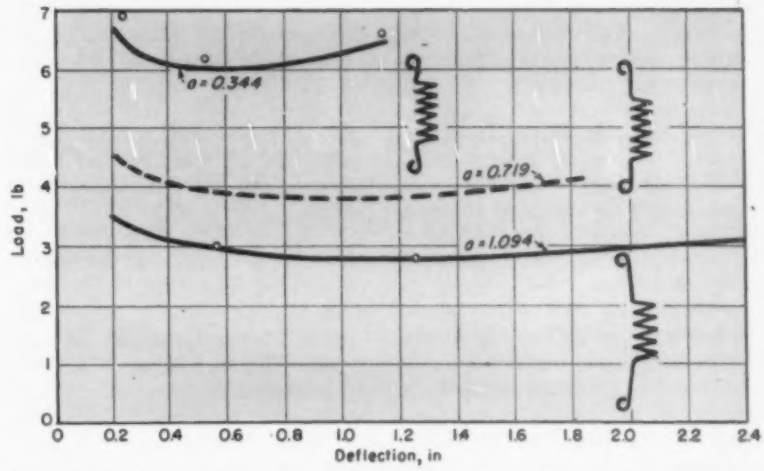


Fig. 10—Arm length plays important role in determining performance curve as illustrated above for nominal spring of Fig. 5. In general, arms must be long for constant force springs with comparatively large deflection. For large forces and small deflections, top curve, arm can be short.

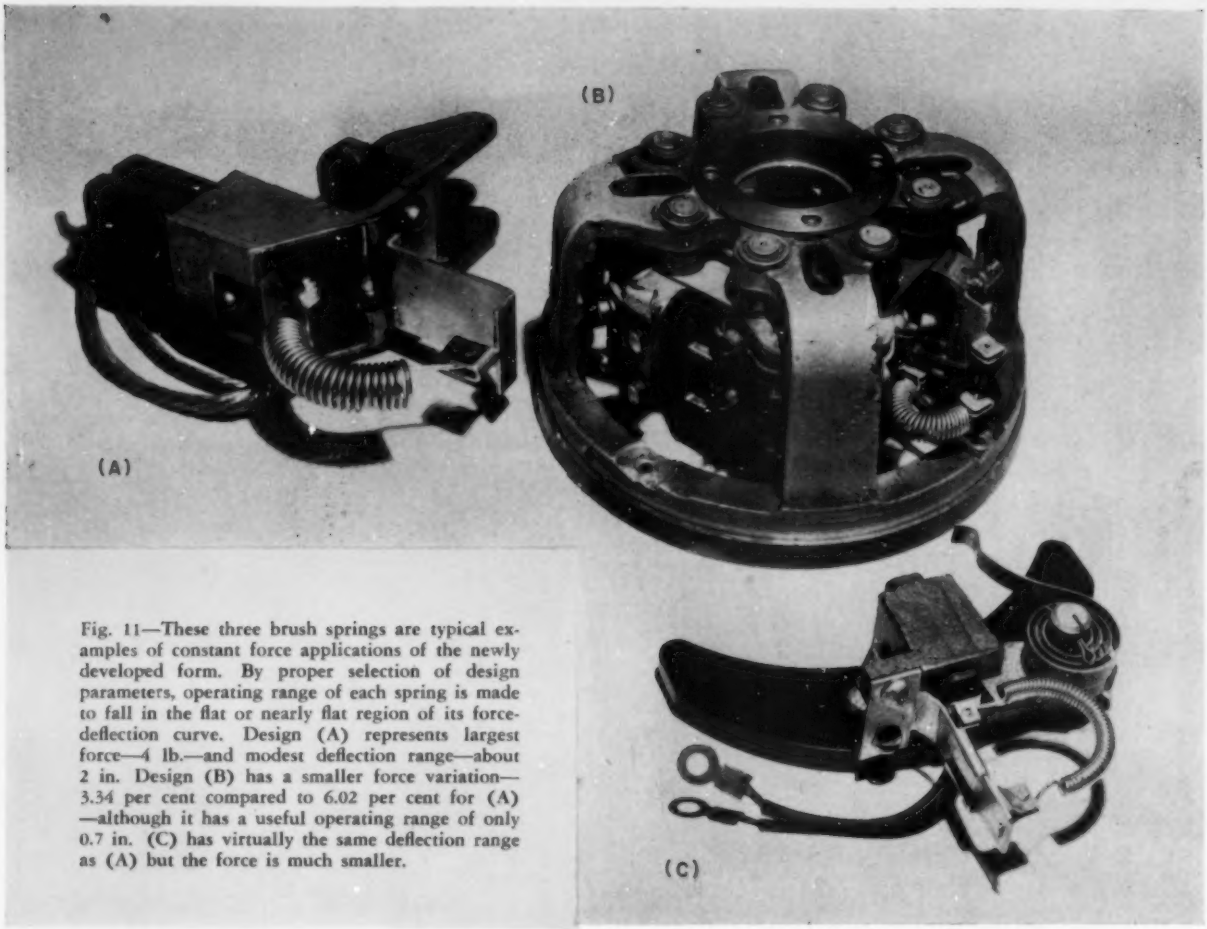


Fig. 11—These three brush springs are typical examples of constant force applications of the newly developed form. By proper selection of design parameters, operating range of each spring is made to fall in the flat or nearly flat region of its force-deflection curve. Design (A) represents largest force—4 lb.—and modest deflection range—about 2 in. Design (B) has a smaller force variation—3.34 per cent compared to 6.02 per cent for (A)—although it has a useful operating range of only 0.7 in. (C) has virtually the same deflection range as (A) but the force is much smaller.

The relationship between force and wire diameter is very similar to that for compression and extension springs. As shown in Eq (1), force is approximately proportional to the fourth power of wire diameter.

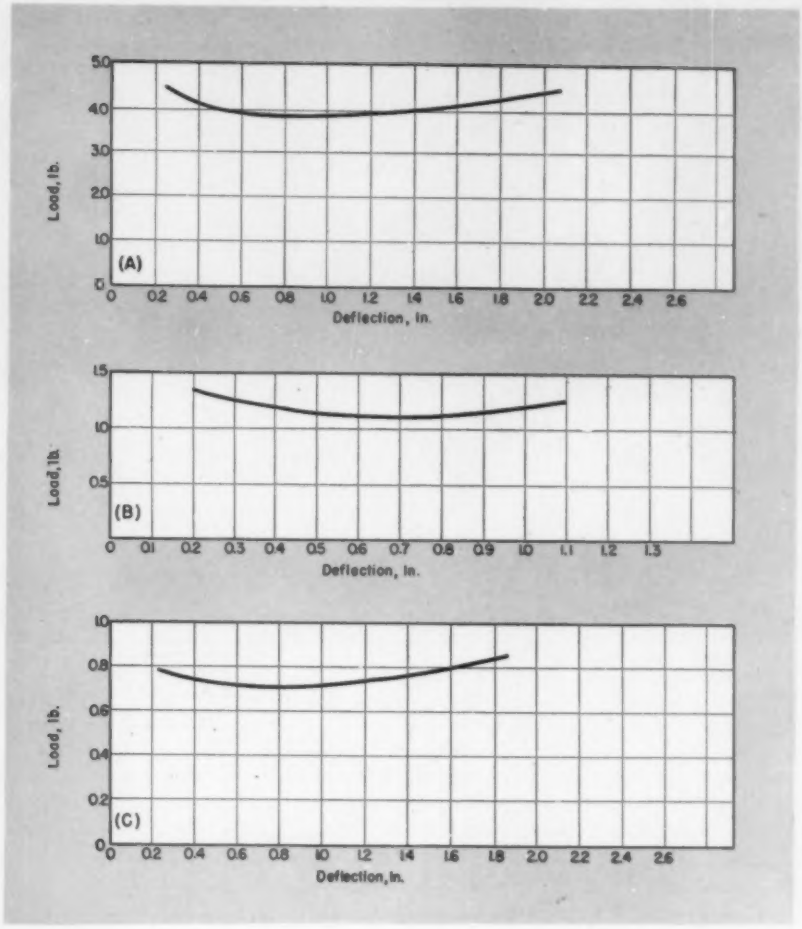
INITIAL TENSION. Design and manufacturing experience indicates that a good rule-of-thumb in selecting proper initial tension for zero-gradient springs is that P_i should be about as large as manufacture permits for the given wire diameter and mean coil diameter. It has been found advisable to pull up the lower end of the curve by specifying the highest possible initial tension and then change other factors to flatten the rest of the curve to reduce force variation. Thus, the nominal design represented by the dotted curve in Fig. 6 has an initial tension $P_i = 6.4$ lbs, very close to the maximum possible for $d = 0.063$ in. and $D = 0.438$ in.

The two curves for $P_i = 3.2$ lbs and $P_i = 0$ show that not only does a smaller initial tension drop the low-deflection end of the curve but also it reduces the force at all deflections. As P_i is decreased below the maximum, the spring becomes a positive-gradient element, other factor remaining constant. The maximum gradient occurs when the magnitude of initial tension is zero.

MEAN COIL DIAMETER. In Fig. 7, the nominal mean coil diameter, $D = 0.438$ in., has been increased and also decreased by approximately the same amount. The increase to $D = 0.500$ in. has raised the high-deflection end of the curve disproportionately so that the force variation with the larger mean coil diameter is now greater. A reduction in mean coil diameter to $D = 0.375$ in. produces a small decrease in force at all deflections.

NUMBER OF TURNS. Since wire diameter remains constant in these tests, the changes in number of turns N in Fig. 8 also represent proportional changes in body length dN. The force-deflection curve drops when the number of turns is increased, the effect of each new coil lessening as the number of coils increases. Also, the increase in number of turns has actually broadened the deflection range by raising the maximum deflection limit at the parallel-arm position. This occurs because a large number of coils lengthens the spring body and therefore raises the hook deflection per unit increase in body deflection angle (θ).

ARM ANGLE. With the nominal arm angle $\alpha = 10$ deg. in Fig. 9, an increase in arm angle reduces the force at any deflection and has a pronounced effect on the deflection range. As noted previously, the maximum body deflec-



tion angle is decreased by the magnitude of the arm angle; the maximum deflection at the parallel-arm position is 15 per cent lower for $\alpha = 20$ deg than for $\alpha = 0$ in Fig. 9. Because the arm angle is measured to the center of the hook on the end of the arm, the sketch for $\alpha = 0$ actually appears as though the arm is bending back over the spring body.

Negative arm angles, in which the center of the hook is bent back over the body, increase the force magnitude and maximum deflection limit further. However, zero and negative arm angles always require some initial deflection; otherwise the spring cannot be flexed by a force parallel to the body. Although most applications will not involve very low deflection angles, the need for initial deflection for zero or negative arm angles usually reduces the practical deflection range in such designs. With a positive arm angle, a Flex'ator may theoretically be used from $\theta = 0$ to 90 deg if the higher initial forces can be tolerated.

ARM LENGTH. In Fig. 10 it is evident that an increase in arm length reduces force and force variation while raising the upper limit of the deflection range. In general, springs for large force, small-deflection applications should have comparatively short arms while those with longer arms will be used to exert lower forces through larger deflections with less force variation.

It has been assumed in considering the effect of changes in both arm angle and arm length that the angles and lengths of both arms are equal. Although it is possible to have different arm angles and lengths on each end, it does not appear now that differences in arm length and angle would provide any more design flexibility than when equal.

BENDING STRESSES IN ARMS. The bends where the two arms leave the end coils, are subject to combined bending and shear stress. By far the largest of these stresses is a pure bending stress; it is possible that the bending stress in the arm may be more critical than the torsional shear stresses in the spring body.

The bending stress in the arms is

$$S_{bend} = \frac{32\ Pa}{\pi\ d^3} \text{ psi} \qquad (4)$$

exactly as is found in the hook arms of extension springs. The effect of the actual combination of stresses at the arm bends may be accounted for by using a stress concentration factor in Eq (4) to obtain a total effective bending stress for comparison with the maximum permissable bending stress for the material and wire diameter used. For example, stress concentration factors in the range of 1.1 to 1.4 have been used in determining stresses in the ends of extension springs.

As is evident in Eq (4), the possibility that bending stress is more critical than torsional shear stress increases as the length of arm (a) increases. If bending stress is too large, the logical step is to reduce the arm length.

FATIGUE LIFE AND MATERIALS

In all life tests, fatigue characteristics were essentially identical to those of extension springs. The expected operating life of each is nearly the same as long as the material operates at the same stress levels.

Although tests have been conducted only on springs made of music wire (A.S.T.M. A228-41), other materials should also be usable.

TYPICAL APPLICATIONS

Three brush spring applications are shown in Fig. 11. In each case, the spring is designed to exert a nearly constant force on the brush as it wears down, thus maintaining uniform pressure on the commutator throughout the useful life of the brush. Less pitting of commutator segments and better commutation in motors and generators are the major improvements obtained. The Flex'ators replaced either larger, positive-gradient torsion springs or power springs.

Typical components finished with Alumilite Hard Coating for high abrasion resistance

Aluminum Company of America

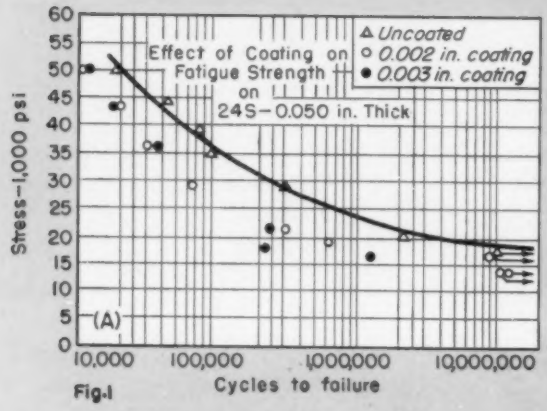
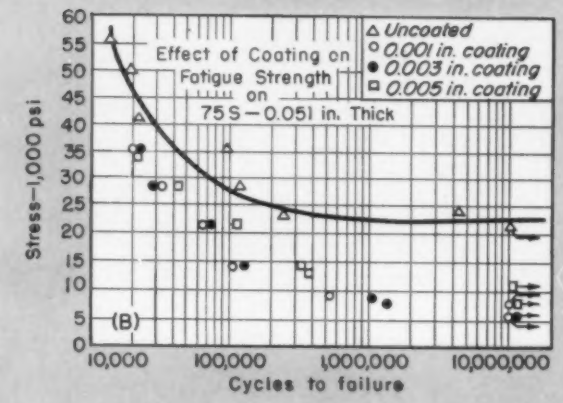


Fig. 1



Mechanical Properties of

Increased hardness and wear resistance are important advantages of hard coatings on aluminum, but both fatigue resistance and tensile strength are reduced—enough to influence design, or even restrict the use of these coatings from some applications.

HENRY A. JOHNSON

1st Lieut., USAF, Wright Air Development Center*

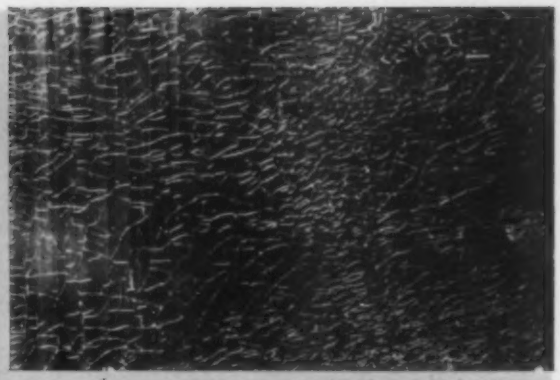
** The opinions expressed are those of the author and do not reflect opinions of Wright Air Development Center or the U. S. Air Force.*

OF THE MANY TYPES of finishes that have been developed for aluminum within the past few years, those that are of particular importance for mechanical applications are the oxide films produced by electro-chemical oxidation of the metal surface. Typical examples are Alcoa's Alumilite 225, 226, 725 and 726, and the Martin Hard Coatings.

With these coatings, surfaces can be produced that are comparable to ni-

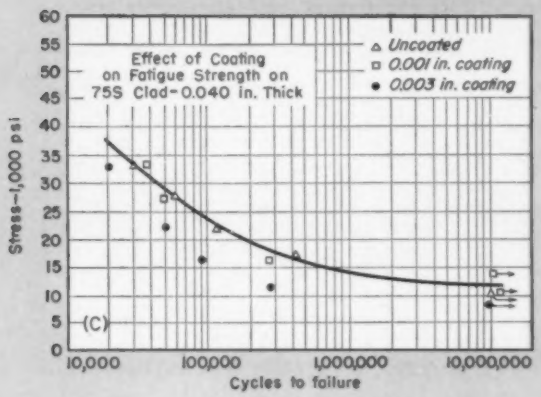
Table I—Summary of Fatigue Tests

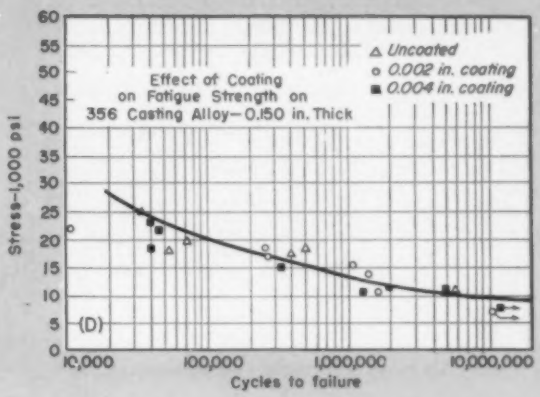
Alloy	Endurance Strength at 10^6 Cycles in psi		Decrease in Endurance Strength
	Uncoated	Coated	Per cent
61S	15,000	6,000	60
24S Clad	11,000	7,500	32
24S Bare	19,000	15,000	1
75S Clad	12,000	10,000	17
75S Bare	22,000	9,000	59
XA78S	26,000	9,000	65
220	7,500	7,500	0
356	8,000	8,000	0



Aluminum Company of America

Fig. 2—Commercially pure aluminum sheet with 0.003 in. coating. Crazed pattern is a result of differential thermal expansion but some cracks were present when panel was removed from the bath.





Aluminum Hard Coatings

trided steel in hardness. Also, the resistance to wear, corrosion and abrasion of most alloys is increased to a significant degree.

As a guide to the proper use of these coatings, a comprehensive test program was sponsored by Wright Air Development Center. Most of this work consisted of evaluating such mechanical properties as fatigue, yield, and compressive strengths and resistance to corrosion and abrasion.

FATIGUE. To investigate the effects of various parameters on fatigue strength, several different alloys were coated as follows: (a) in thicknesses varying from 0.001 to 0.005 in.; (b) on one side as well as on both sides; (c) on half the gage length of the specimen as well as on the full length.

Each specimen was tested in reversed bending in a Baldwin-Lima-Hamilton constant-torque fatigue machine for 10 million cycles or failure, depending on which occurred first. The results of these tests are summarized in Table I; typical S-N curves are reproduced in detail in Fig. 1 (A)-(D). It will be noted from these curves that the coating reduced the fatigue strength of the wrought alloys but did not affect 356, the casting alloy.

Where decreases were encountered, they were not attributed to a loss in specimen thickness during the oxidation process. Rather, they were con-

Table II—Tensile Test Data 75S-T6—0.033 In. Thick

Coating Thickness in.	Area of Original Parent Metal, in.²	Area of P.M. Remaining After Coating, in.²	Load at Y.S. 0.2% Offset lb.	Y.S. Based on Original Area psi.	Load Carried by P.M. lb.	Load Carried by Coating lb.	Load Carried per 0.001 in. Coating, lb.	Load Ultimate lb.	U.T.S. Based on Original Area psi.	Per cent Elong. In 2 in.
0.000	0.0165	———	1210	73,300	Based on 73,400 psi. Y.S.	———	———	1320	80.000	8.5
0.000	0.0162	———	1190	73,500	———	———	———	1300	80 300	10.0
0.0005	0.0160	0.0158	1140	71,200	1160	—20	—20	1290	80,600	7.5
0.0005	0.0163	0.0160	1160	70,700	1175	—15	—15	1300	79,800	8.5
0.001	0.0163	0.0157	1160	71,200	1152	8	4	1300	79,800	7.5
0.001	0.0162	0.0157	1160	71,600	1152	8	4	1310	81,000	8.0
0.002	0.0162	0.0151	1130	69,800	1110	20	5	1270	78,400	7.0
0.002	0.0163	0.0153	1140	70,000	1123	17	4	1300	79,800	7.0
0.003	0.0163	0.0147	1120	68,900	1080	40	7	1270	78,000	7.0
0.003	0.0158	0.0143	1120	71,000	1050	70	12	1240	78,500	7.0
0.004	0.0163	0.0142	1100	67,500	1042	58	7	1230	75,500	5.5*
0.004	0.0162	0.0141	1100	67,900	1036	64	8	1240	76,600	5.5*
0.005	0.0162	0.0136	1050	64,900	1000	50	5	1180	72,900	6.5*
0.005	0.0161	0.0135	1050	65,200	991	59	6	1160	72,100	6.0*

* Coating started to peel off.

Table III—Compression Test Data 75S-T6—0.051 In. Thick

Coating Thickness, in.	Area Composite, in.²	Area Parent Metal, in.²	Load Yield, lb.	Composite Y.S., psi.	Load Carried by P.M., lb.	Load Carried by Coating, lb.	Load Carried Per 0.001 Inch Coating, lb.
0.000	0.0253	———	1810	71,500	Based on 71,500 psi. Y.S.	———	———
0.000	0.0253	———	1810	71,500	———	———	———
0.0005	0.0252	0.0249	1810	71,800	1780	30	60
0.0005	0.0252	0.0249	1790	71,100	1780	10	20
0.001	0.0256	0.0250	1790	69,900	1788	2	2
0.001	0.0256	0.0250	1780	69,600	1788	—8	—8
0.002	0.0261	0.0252	1910	73,200	1800	110	55
0.002	0.0261	0.0252	1910	73,200	1800	110	55
0.003	0.0257	0.0250	1950	75,900	1788	162	54
0.003	0.0257	0.0250	1930	75,100	1788	142	47
0.004	0.0268	0.0246	1950	72,800	1760	190	47
0.004	0.0268	0.0246	1930	72,000	1760	170	42
0.005	0.0272	0.0244	1980	72,800	1745	235	47
0.005	0.0272	0.0244	1970	72,500	1745	225	45

sidered to be a result of stress concentrations at minute cracks in the surface of the coating. (See Fig. 2.) This was substantiated by the casting alloy data. The fatigue properties were essentially unchanged by the coating since the surface of a casting inherently has enough pores and irregularities to offset the effect of the coating.

Increasing the thickness of the coating from 0.001 to 0.005 in. showed the decrease in fatigue strength was independent of coating thickness for high-strength bare alloys such as 24S, 75S and XA78S. The effect on the clad alloys was to decrease the endurance limit beyond the reduction that was already experienced as a result of the cladding. Specimens that were coated on one side only, and one-half the gage length were found to exhibit decreases in fatigue strength of the same magnitude as those coated on both sides and full length.

Thus, when fatigue is a design criterion, proper allowance must be made for reductions in the endurance limits of wrought aluminum alloys. An attempt to counteract these reductions indicated that an aging treatment at

Table IV—Salt Spray Test Data

Alloy	Days to Failure					
	0.0005 in. Coating	0.001 in. Coating	0.002 in. Coating	0.003 in. Coating	0.004 in. Coating	0.005 in. Coating
61S	220	*	*	330 (single pit) (one specimen)	*	*
XA78S	330 edge pits	*	*	*	300	330 pits starting
24S	60	90	90	150		150
24S clad	60	90	220	255	180	270
75S	220	*	*	300	270	330
					330 pits at edge	pits at edge
356	**	330	**	330 pits starting	**	*
220	**	180	**	220	**	*

* Specimen did not fail in 330 days.
** The two casting alloys, 220 and 356 were tested with only 0.001, 0.003, and 0.005-inch coatings.

Table V—Abrasion Test Data for Eleven-Month Exposure to Atmospheric Conditions

Alloy	Grams of 180 Mesh SiC Abrasive*					
	0.0005 in.** Coating	0.001 in.** Coating	0.002 in.** Coating	0.003 in.** Coating	0.004 in.** Coating	0.005 in.** Coating
61S	49	87	190	413	525	599
XA78S	79	120	236	266	389	465
24S	48	61	124	222	207	216
24S clad	26	122	248	546	557	420
75S	58	117	204	294	427	583
356	62	133	278	448	650	759
220	48	68	140	183	240	249

* All values given are in grams of 180 mesh SiC abrasive necessary to wear through coating when exposed to 20mm. air pressure in an Arlt Abrasiometer.
** Coating thickness values are approximate

Table VI—Abrasion Test Data for Eleven-Month Exposure to High Humidity 80-90 F

Alloy	Grams of 180 Mesh SiC Abrasive*					
	0.0005 in. Coating	0.001 in. Coating	0.002 in. Coating	0.003 in. Coating	0.004 in. Coating	0.005 in. Coating
61S	43	78	182	316	398	—
XA78S	49	85	144	181	278	289
24S	39	62	123	168	99	115
24S clad	23	124	241	410	423	580
75S	51	97	182	233	362	411
356	60	113	250	326	515	709
220	24	41	104	125	128	178

* All values given are in grams of 180 mesh SiC abrasive necessary to wear through coating when exposed to 20 mm. air pressure in an Arlt Abrasiomeetr.

350F for 10 hours improved the fatigue resistance of a 61 S-T4 alloy. Improvements were also effected on 75S and 61S alloys using a hot 5 per cent dichromate solution, but more extensive testing is required to evaluate these findings.

TENSILE STRENGTH. Applying a hard coating to an aluminum component reduces the tensile strength of the part in proportion to the thickness of the coating. This is a result of a loss in parent metal equal to one half the coating thickness, and the low tensile strength of the coating itself. By determining the difference between the strength of coated and uncoated specimens of exactly the same cross-sectional area, tensile yield values of 10,000-15,000 psi were estimated for the coating.

Typical tensile test data for 75S-T6 alloy are listed in Table II. The loss in yield strength for various thickness can be obtained from the column entitled "Yield Strength Based on the Original Cross-Sectional Area." In terms of the load at yielding, these reductions ranged from 2.5 to 11.8

Fig. 3—Alumilite Hard Coatings and Martin Hard Coatings have exceptional resistance to abrasion, corrosion and erosion. The Alumilite Hard Coatings has been applied to this gun blast tube and impeller to protect against erosion. The Martin Hard Coatings is used on the aluminum orthopedic brace to protect this part against abrasion.

Fig. 4—Operator preparing to rack up aluminum articles for immersion in anodizing tank to apply hard coating.

Aluminum Company of America

percent as the coating thickness was increased from 0.001 to 0.005 in.

COMPRESSIVE STRENGTH. Compression tests, on the other hand, indicated the coating was at least as strong or stronger than the base metal. Estimates for compressive yield strength of the coating, obtained in a manner similar to the tensile values, were found to be between 50,000 and 60,000 psi. These values apply only to the coating as bonded to the base material.

Test values for 75S-T6 shown in Table III indicate that the coating did not effect any reduction in strength of the alloy. In some cases a slight improvement in properties was found. This was also true for the other commercial alloys. For design purposes therefore, it would be considered good practice to use the original area of the parent metal for calculating compressive strength.

CORROSION. To evaluate corrosion and erosion test results, it is necessary to determine the coating composition for each of the different alloy types. For those commercial alloys containing little or no copper, a good coating free of blisters and other surface defects can be obtained easily. For those alloys such as 24S which contain appreciable amounts of copper, surface defects become noticeable and the poor test results bear this out. Copper contents higher than 5 percent would most likely cause considerable difficulties in obtaining good coatings. In all cases, however, an improvement in the corrosion resistance of the alloy was effected as a result of the coating.

Salt spray test data for the more common alloys are shown in Table IV. From this table it can readily be seen that the hard coating affords excellent protection against a salt spray environment for all alloys except 24S. Also, coatings that are more than 0.003 in. thick are not as effective as those in the 0.002-0.003 in. range. This is attributed to the tendency of

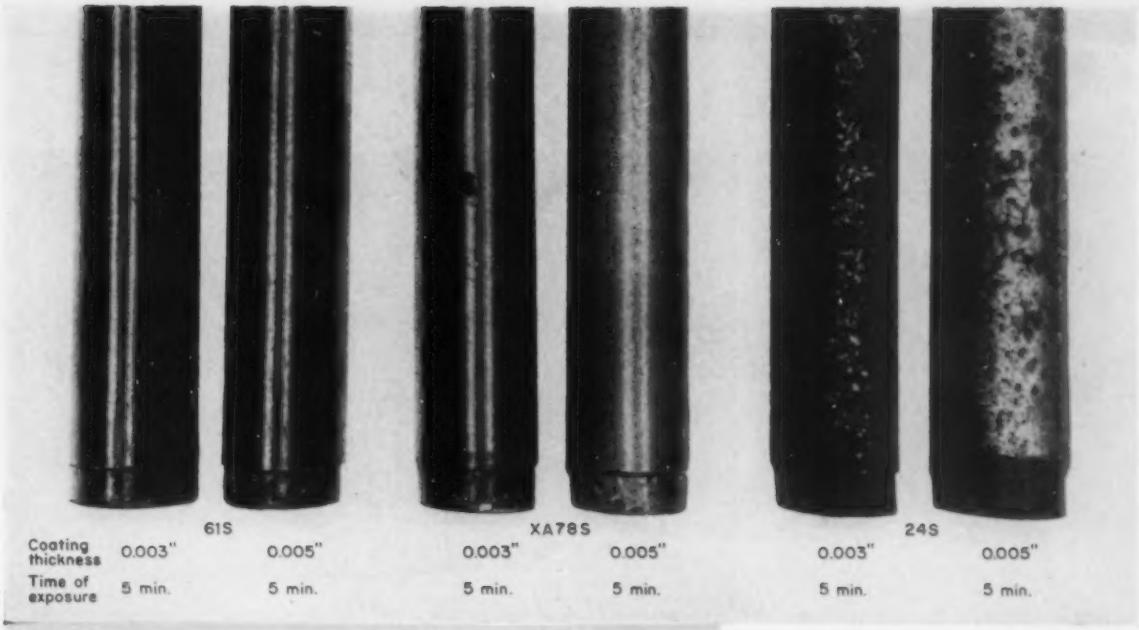


Fig. 5—Effects of rain erosion on hard coated aluminum specimen by one inch rainfall per hour at 500 mph.

Table VII

Alloy	Coating Thickness, in.	Time, days
24S	0.0005	150
	0.001	180
	0.002	180
	0.003	150
	0.004	150
	0.005	60
Clad 24S*	0.004	30
	0.005	30
XA78S	0.0005	120
	0.001	180

*At the end of 220 days, these were the only coating thicknesses that pitted.

Table VIII

Alloy	Coating Thickness in.	Time of Exposure, min.
24S clad	0.003	40
61S	0.003	35
75S	0.003	26
61S	0.005	25
XA78S	0.003	25
24S clad	0.005	20
75S	0.005	5
XA78S	0.005	5
24S bare.	0.003	3(est)
24S bare	0.005	1(est)

a coating to become porous as its thickness is increased. In general, these tests indicate that the hard oxide coatings offer better protection against salt spray than is possible with conventional anodized and electroplated coatings. Atmospheric and humidity exposure tests were also performed on coated samples of various commercial cast and wrought alloys. At the end of a seven-month exposure to the atmosphere at Buffalo, N. Y. the only failures that occurred were in the 24S alloy.

Another set of specimens were exposed to a high relative humidity at 80 F to 90 F for extended periods of time. This had the effect of softening the coating in addition to showing some deterioration. The test specimens which showed some visual deterioration under the humidity test, and the corresponding time of exposure are tabulated in Table VII.

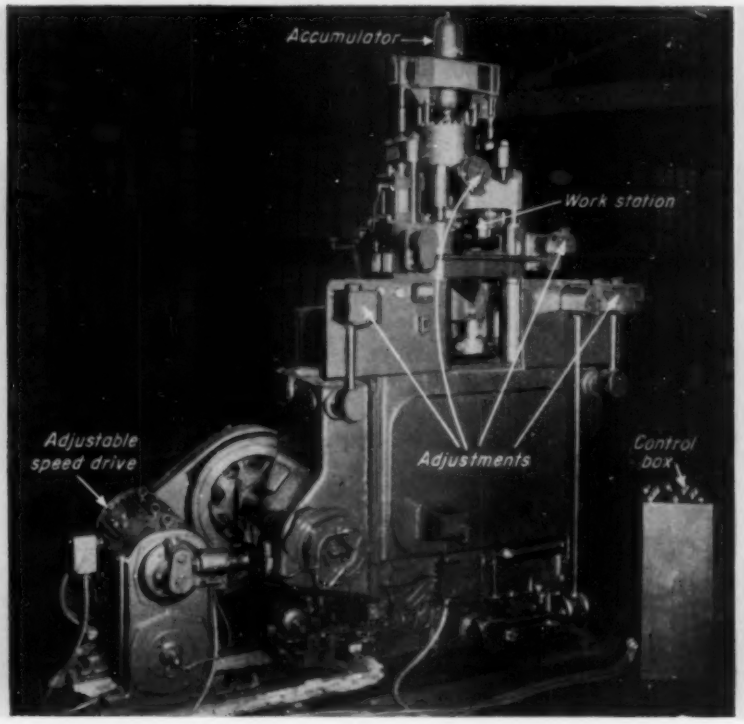
ABRASION. Since other investigators have related abrasion resistance to the degree of hydration in regular anodized coatings, a similar series of tests were run on the heavy oxide coating to determine the magnitude of this softening effect. The coating thicknesses were measured on a metallograph and the "as coated" abrasion resistance determined on an Arlt Abrasiometer. The Abrasiometer is a device that causes a stream of abrasive particles (180 mesh carborundum) to impinge upon the surface to be tested. The abrasive stream is controlled by air pressure, and the failure point of the material can be discerned visually.

Results of these tests are given in Tables V and VI. There is a general decrease in the abrasion resistance of all the alloys with increasing time of exposure to atmosphere and humidity. The decrease is greater under the high humidity conditions than it is under exposure to the atmosphere. The 24S bare shows wide scatter under all conditions and is not considered to be a suitable alloy for use with the hard coating processes when abrasion resistance is required.

The applicability of coated specimens to withstand rain erosion was also tested by allowing a uniform rainfall to strike the leading edge of an airfoil contoured specimen, rotating at 500 mph and recording the elapsed exposure time when damage to the coating was evident. These data are summarized in Table VIII. Fig. 5 illustrates the appearance of 24S, 61S, and XA78S specimens after exposure to the test for different lengths of time.

DESIGN FEATURES

A PART such as this Yale lock cylinder which is being produced at the rate of 20 per minute is representative of the type of component for which this new Baldwin-Lima-Hamilton multiple action compacting press is designed. Four column construction is aimed at maintaining exact die alignment and rigidity of tooling, a factor which points up an increased die life and the use of cheaper dies.



Advanced Compacting Press Design

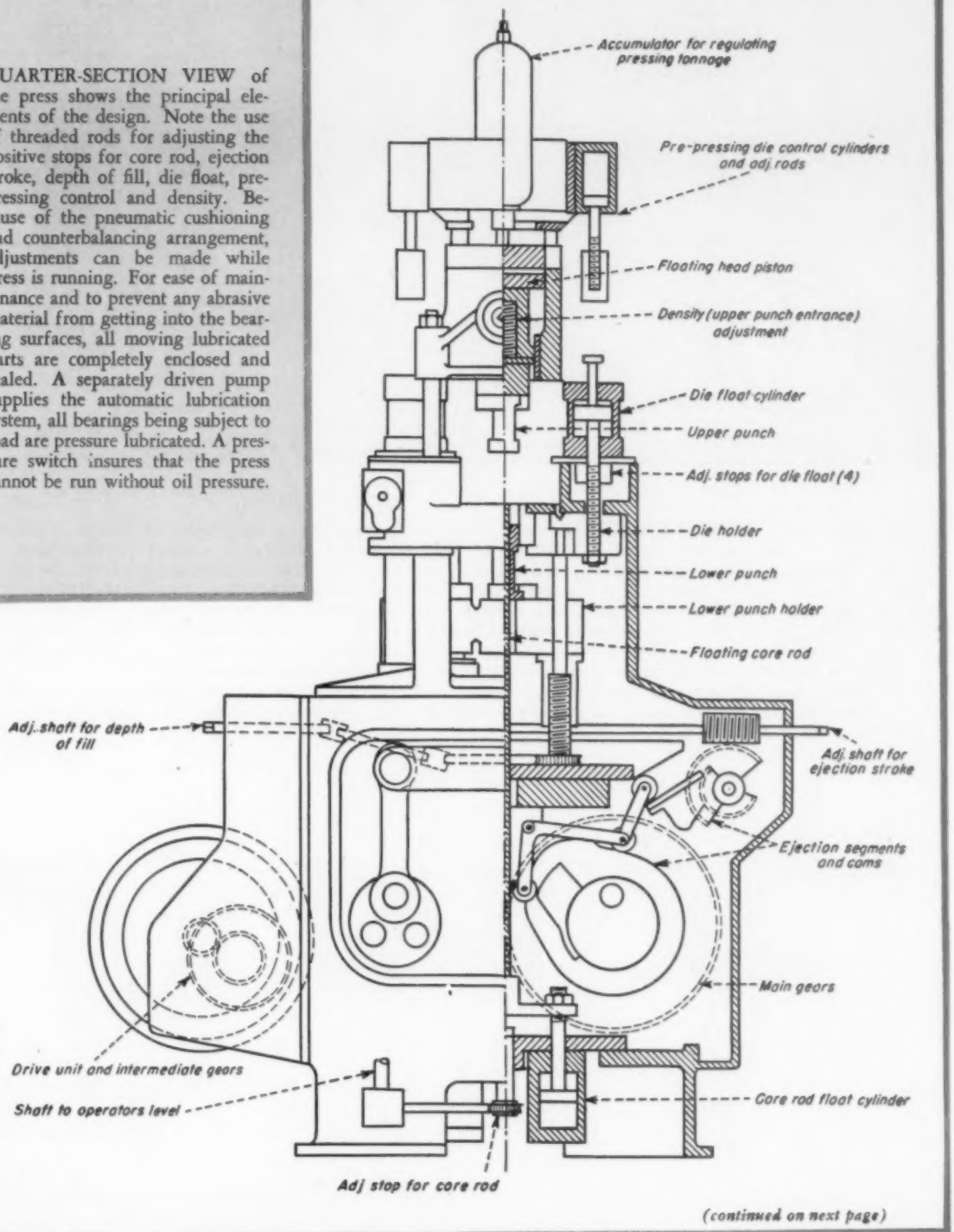
Because of the lag between available compacting presses and advancements in powder metallurgy, designers have been limited in their attempts to fully utilize the many advantages possible with powder metal parts. With fabricators primarily dependent upon presses modified for powder metal use, design restrictions were centered in depth of fill, ejection capacity, density control and part configuration. Prompted by these factors, Baldwin-Lima-Hamilton Corp. came up with a completely new approach to compacting presses, one designed specifically for powder metal production.

By designing the die holder and core rod to float independently of each other against pneumatic cushions and using adjustable positive stops to control depth dimensions, the engineers built into the press the means to closely control density within an adjustable depth range. In terms of press production, this allows the operator to vary the stroke of the press during a production run without stopping the press or modifying the die. For the designer, it means greater latitude in his basic design since depth adjustments can be made in increments of 0.001 in. without changing the uniform density required. Thus, at a controlled density, dimensional stability is maintained during the sintering operation resulting in an almost negligible reject factor.

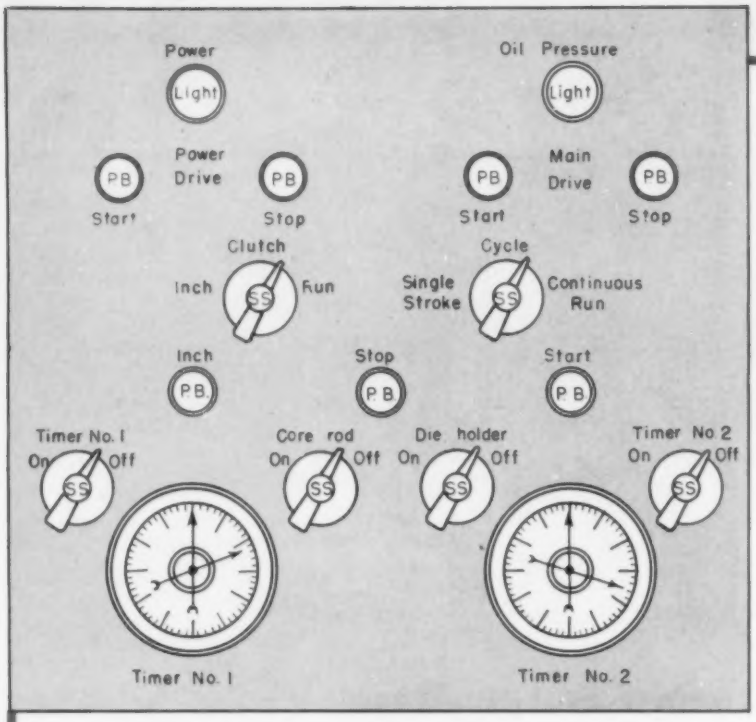
In construction, the press is a mechanically operated, four column design, crank type model equipped with a flywheel, pneumatic clutch and pneumatic brake. Rated pressures up to 100 tons are obtained by a hydraulic accumulator which makes it possible to accurately control the compacting pressure to prevent overloading of the press or dies. A production rate ranging from 4 to 24 strokes per min is derived from a variable speed drive unit powered by a totally enclosed motor. Adjustments such as depth of fill, stroke and float are made without the conventional changing of cams.

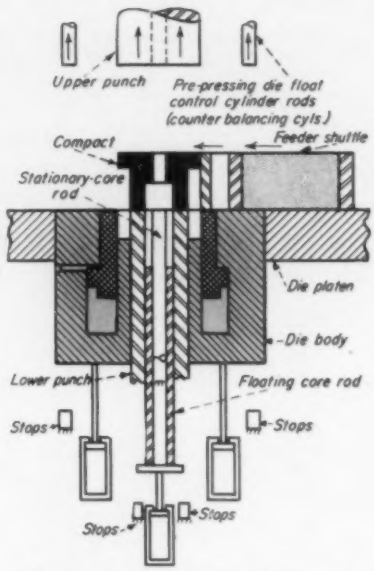
IN NEW PRODUCTS

QUARTER-SECTION VIEW of the press shows the principal elements of the design. Note the use of threaded rods for adjusting the positive stops for core rod, ejection stroke, depth of fill, die float, prepressing control and density. Because of the pneumatic cushioning and counterbalancing arrangement, adjustments can be made while press is running. For ease of maintenance and to prevent any abrasive material from getting into the bearing surfaces, all moving lubricated parts are completely enclosed and sealed. A separately driven pump supplies the automatic lubrication system, all bearings being subject to load are pressure lubricated. A pressure switch insures that the press cannot be run without oil pressure.


Accumulator for regulating pressing tonnage
Pre-pressing die control cylinders and adj rods
Floating head piston
Density (upper punch entrance) adjustment
Die float cylinder
Upper punch
Adj. stops for die float (4)
Die holder
Lower punch
Lower punch holder
Floating core rod
Adj. shaft for depth of fill
Adj. shaft for ejection stroke
Ejection segments and cams
Main gears
Drive unit and intermediate gears
Shaft to operators level
Core rod float cylinder
Adj stop for core rod

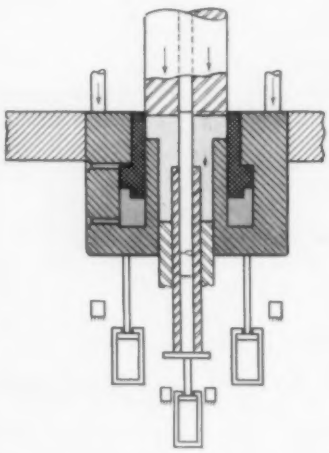
(continued on next page)



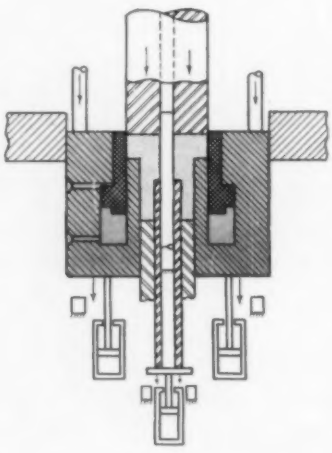


① Feed shuttle contacts finished compact

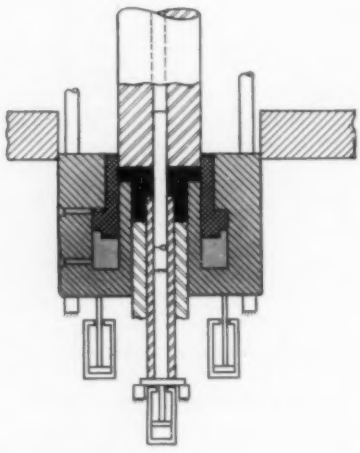
CONTROL PANEL LAYOUT. Press can be cycled for a continuous run, semi-continuous run with dwell at any predetermined point, single stroke, single stroke with dwell, and inching. Circuit is essentially designed to release the brake, engage the clutch, apply the broke and hold, if desired, for an adjustable timed interval. Other controls consist of a pressure switch which automatically disengages clutch and applies brake when oil pressure drops below a safe value, and core rod and die holder selector switches for additional control over pressing operation. Core rod switch, when "on" retracts floating core rod against stops, and then returns floating core rod to original position while feeder shuttle is still over die cavity. This permits more uniform filling for parts with thin-walled sections. With die holder switch "on", die cushion cylinders remain exhausted until lower punch begins to eject part from the die. This feature then insures no lost motion between lower punch and compact.



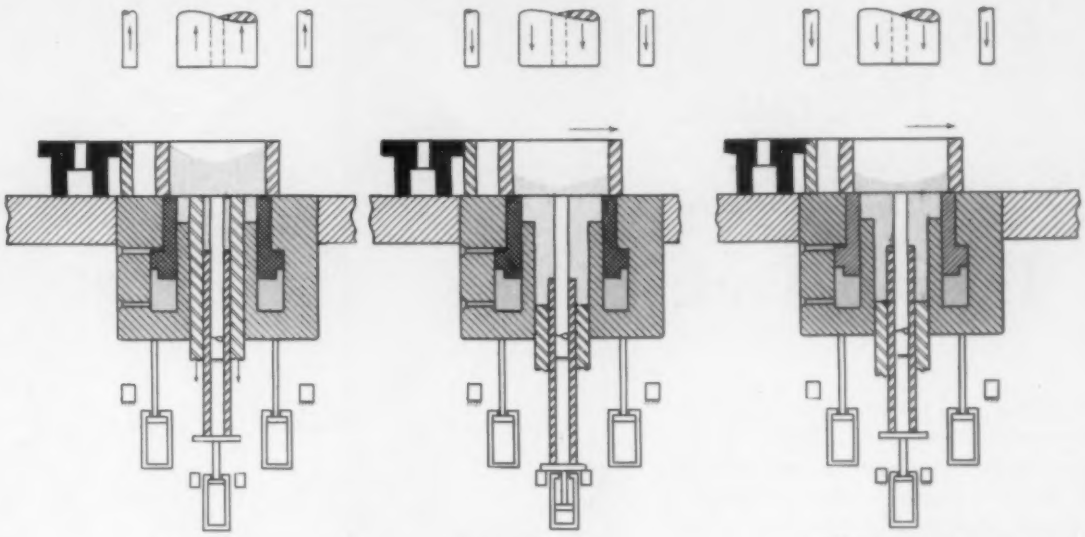
⑤ Beginning of compacting



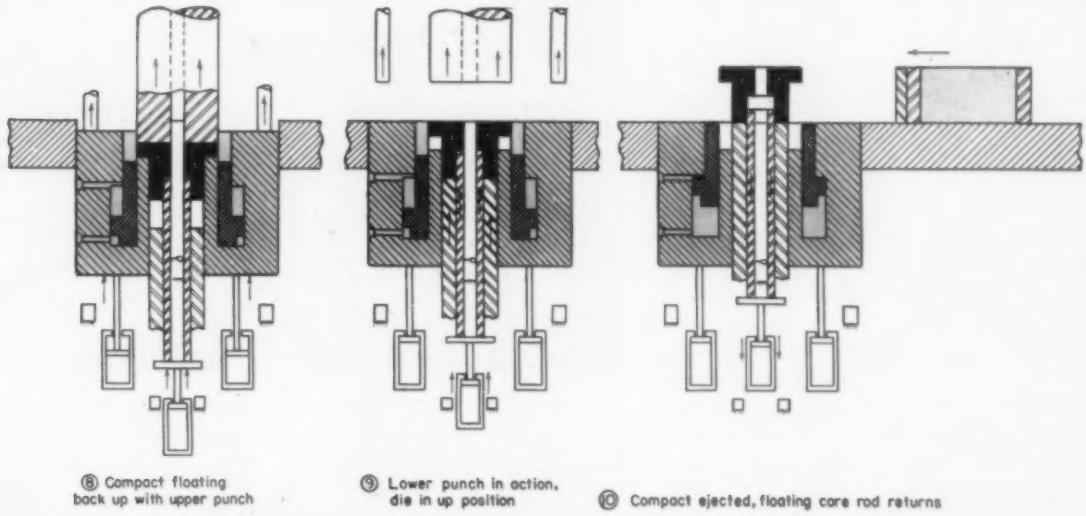
⑥ Both die and core rod floating



⑦ Compacting completed, upper punch starts up



SCHEMATIC DIAGRAMS, Figs. 1-10, show the sequence of pressing operations to produce the lock cylinder shown in the first illustration of this article. After the lower punch has ejected the completed cylinder from the die cavity, a shuttle type feeder moves across the bed to both eject the cylinder from the pressing station and to fill the die cavity for the next operation. A uniform amount of powder is always carried by the shuttle, the relative amount used being a function of the position of the adjustable stops. After the die cavity has been filled with the lower punch in its lowest position and the core rod in its normal position, the compacting phase of the cycle begins. As the upper punch moves down, both the die and core rods are floating. Upon completion of the compacting, the upper punch is retracted and the compact is floated up with the core rod. Final phase is the moving of the lower punch to eject the compact from the die cavity.

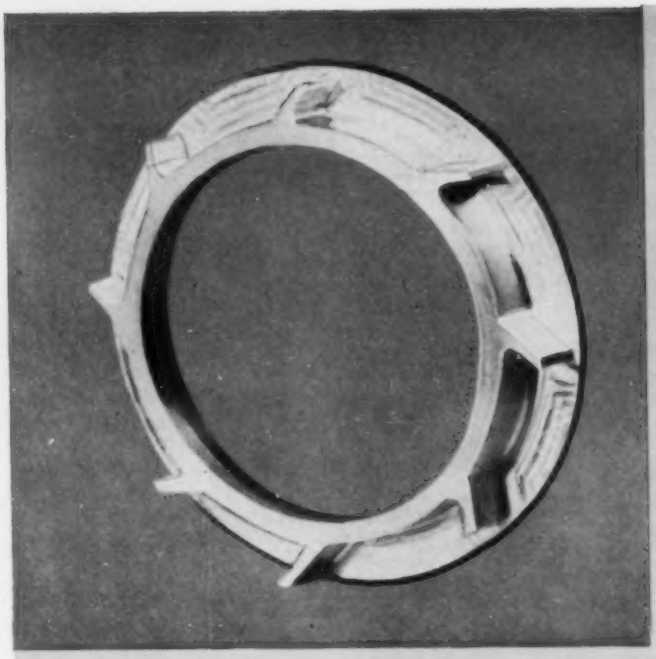

⑧ Compact floating
back up with upper punch
⑨ Lower punch in action,
die in up position
⑩ Compact ejected, floating core rod returns

Hydraulic Servo-Valve for Tracing Work

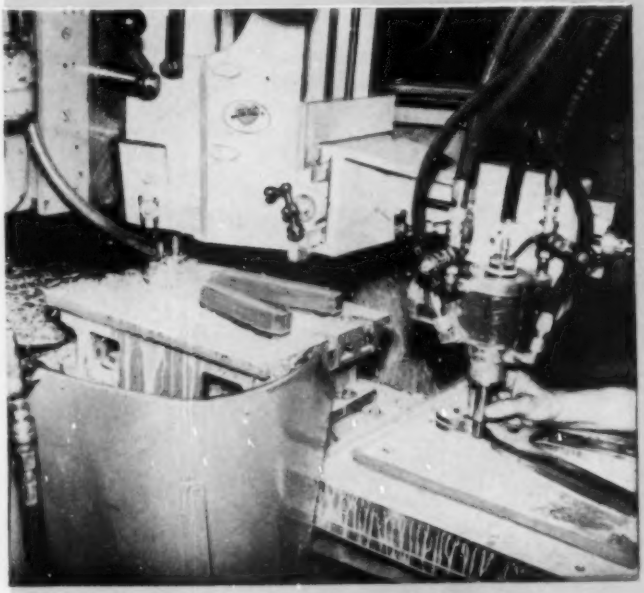
A hydraulic servo valve which mechanically resolves the deflection of a stylus spindle into directional vectors to precisely position the spools to control oil flow to actuating elements is the heart of a tracer head design by True-Trace Corp., El Monte, Calif. Aimed specifically for adoption to standard machine tools, the unit meters the flow of oil and controls the direction of flow to give a master-slave relationship as close as 0.001 in.

In the Model A-3D, three dimensional valve design, each of the three spools is set at right angles to the other and parallel to the machine motion it controls. Movement of all spools is controlled by a common spindle on which are formed three integral spherical surfaces, one of which serves both as the spindle pivot point and contacting surface for movement of the spool controlling the vertical positioning. Two of the spools are in the same horizontal plane and are tied together through a Scotch Yoke assembly in contact with a spherical surface on the spindle. Thus, lateral deflection of the stylus causes the spindle to pivot about its lower spherical surface moving the Scotch Yoke assembly in relation to the stylus deflection angle. Because of this arrangement, the travel of one horizontal spool is a geometric complement of the other—net result being a uniform rate of feed for any given setting of the rate cam regardless of stylus deflection.

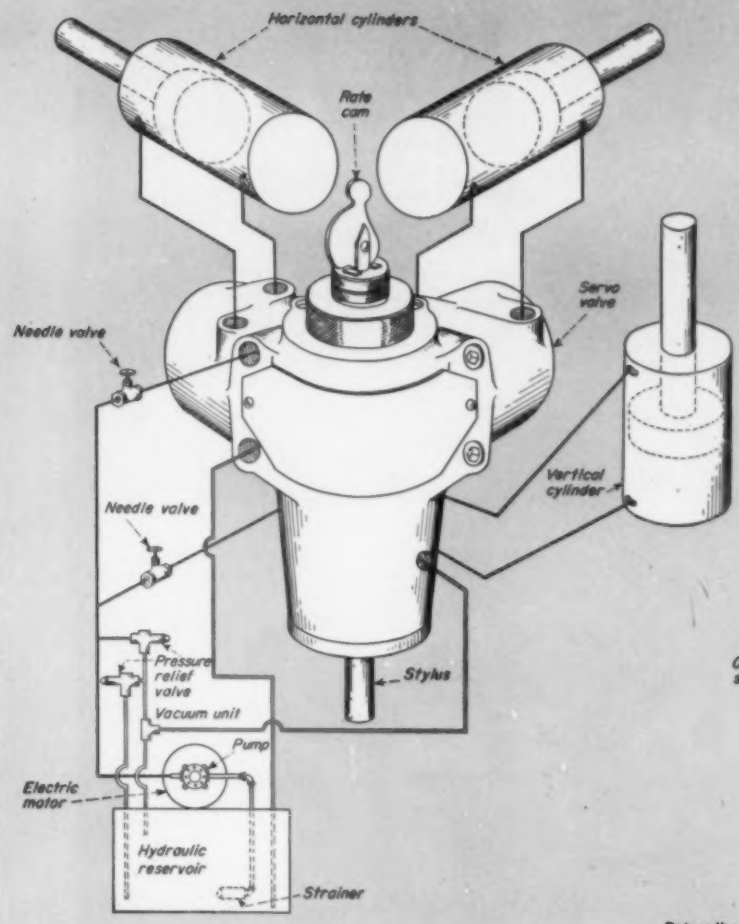
Operation of the tracer head is based on an operator manually moving the stylus into contact with the master. But since the movements of the spools can be adjusted for desired rate of oil flow, the feed rate of the controlled machine tool is held constant.



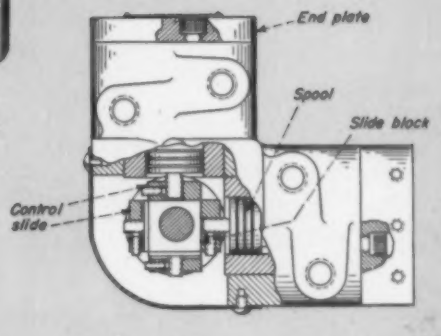
REDUCTION in machining time of this impeller from 1½ hrs to 20 min for each of a lot of 80 parts was obtained by switching from conventional milling practice to hydraulic tracing. Rejection rate was cut from 5 to 0.5 percent.

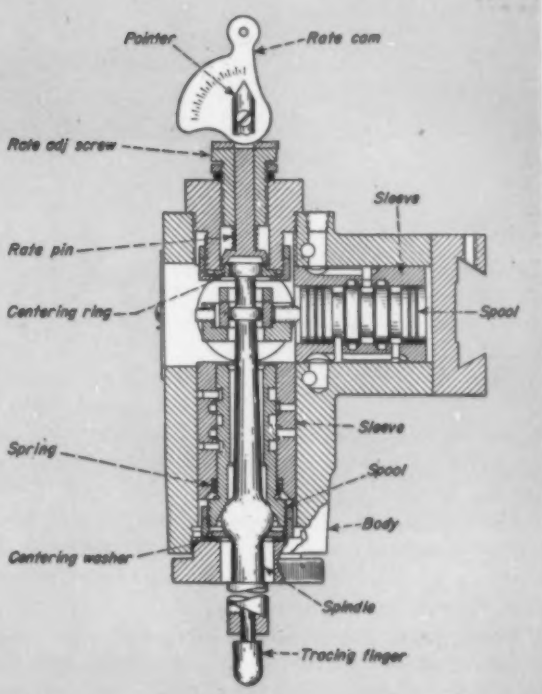


TRACER HEAD is shown operating in conjunction with a standard milling machine to finish a rough-sawed aluminum fitting at Convair's San Diego plant. Unit is controlled by the operator moving the stylus against the contours of the template, stylus pressure necessary being only 4 oz.



SCHEMATIC DIAGRAM of hydraulic circuit and components required for tracing any configuration in a plane of 360 deg. Stylus deflection is translated through the hydraulic servo valve to accurately position the vertical and two horizontal slide cylinders. Needle valves in circuit are for very slow feed rates in horizontal directions or to control rate of volume input in vertical motions.

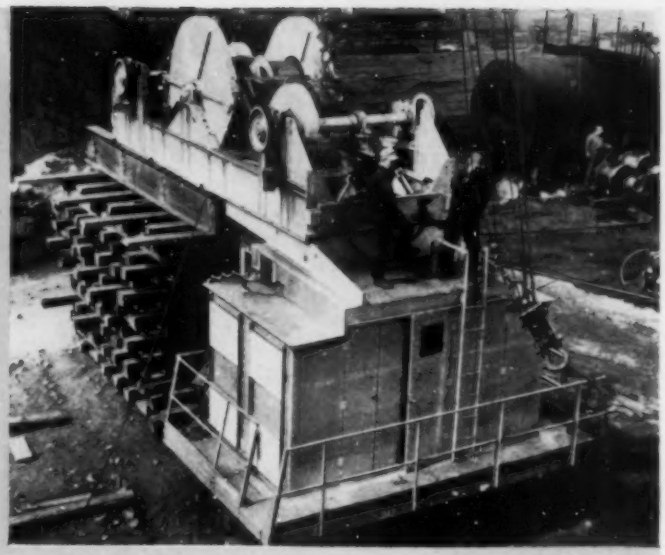




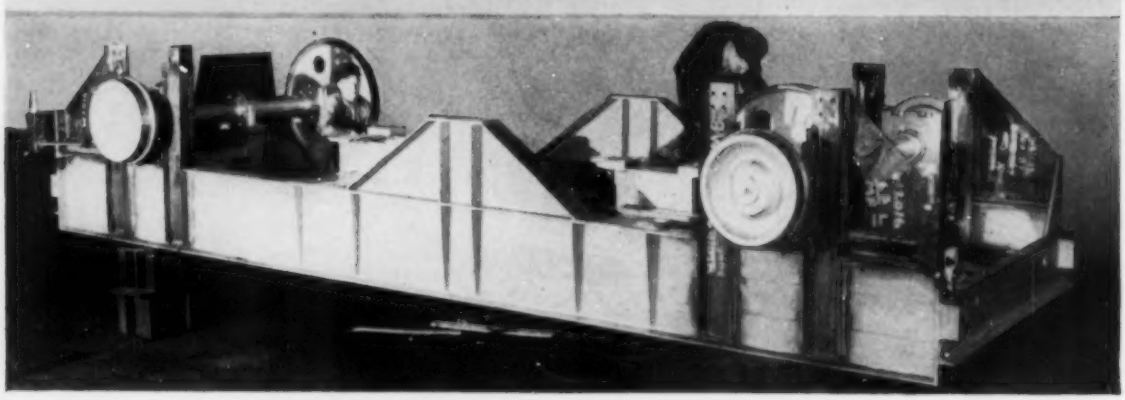
CROSS-SECTION VIEW of the three dimensional hydraulic servo valve which controls the volume of oil flow, pressure being constant. The Scotch Yoke assembly is the key element for the resolution of spindle deflection into the correct direction vectors. Since the middle spherical surface on the spindle is free to move horizontally or vertically through the slide block of the yoke to which the spools are, in turn, connected, spindle deflection is immediately translated into precise spool movement.

Rate control of oil flow is obtained by a pair of mating internal and external conical surfaces. For a reduced flow rate, the rate cam is pivoted to lower a rate pin onto a centering ring reducing the degree to which the spindle can deflect. This, in turn, reduces the amount of movement of the horizontal spools and hence reduces the port opening and volume of oil flow.

SHOWN ON TIMBER cribbing, the new lightweight trolley is ready for hoisting. Welded design plus extensive use of aluminum alloys and improvements in motor design giving more hp per lb of weight, increases trolleys free digging capacity about 72 percent over old unit.



MAIN TROLLEY FRAME, shown here with drive wheels in place, is fabricated of welded structural shapes and plates. In the main beams, the greatest weight saving was realized through the use of built-up lightweight deep section griders.



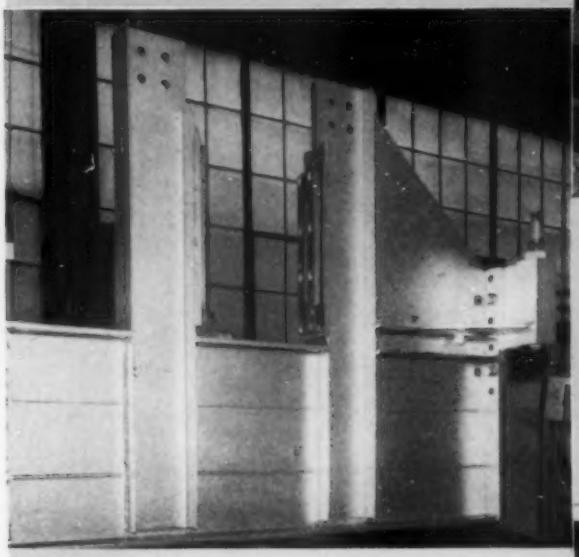
Welding Pays Off in Trolley Redesign

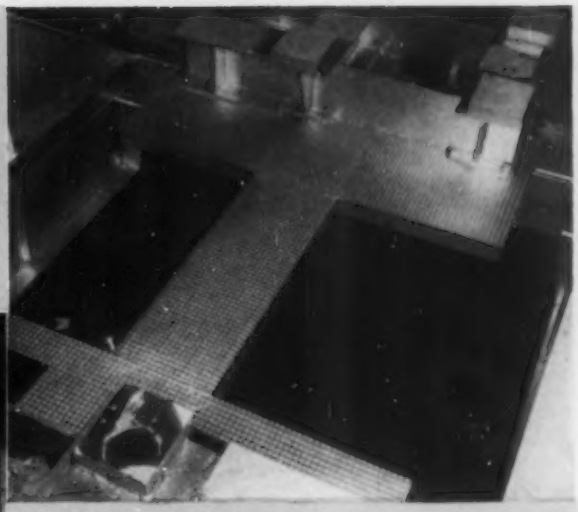
Given the problem of designing a new, larger capacity trolley to run on an existing ore bridge, and yet not increase the overall weight on the bridge span, engineers of the Dravo Corp., Pittsburgh, Pa. went almost exclusively to the use of welding in the construction of the new unit. Then by also adopting aluminum alloys for structural members wherever possible, the resulting 36 percent reduction in weight was translated into a 54 percent boost in payload capacity.

The original trolley had an all-riveted frame constructed from heavy I-beams, angles and plates with the drums and bearing stands being machined from steel castings. In comparison the new trolley frame is completely welded as are the drums and bearing housings. Total reduction in weight: from 17,000 lbs to 10,800 lbs, a 6,200 lb saving.

Time played a big role in the new design approach. The original trolley was constructed over 24 years ago. Since that time, two factors have come into common acceptance—welding as a method for fabricating structural and mechanical parts and aluminum alloys for many structural applications. Going hand-in-hand with these factors were improvements in joining techniques. Cost-wise, the new trolley design, even when based on current costs, shows a marked reduction compared to the original construction. Expensive patterns, and assembly and machining time required for the rivetted frame and its components were eliminated or significantly reduced.

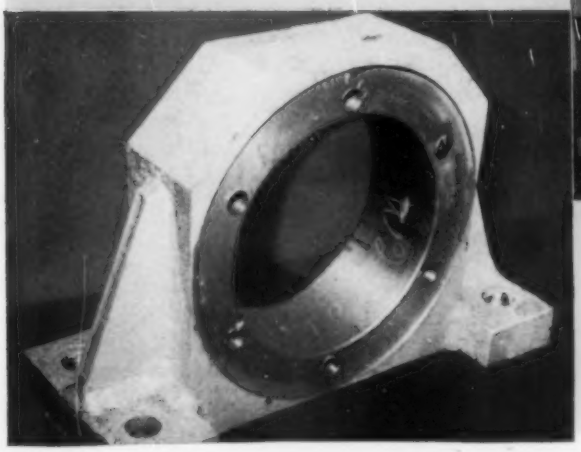
THE MAIN GIRDERS, below, of the trolley frame were fabricated by burning two WF beams through the center, making two T's which then were welded to a web plate to give a deep light-weight section. Members perpendicular to the girder are hangars for one of the trolley axles. Weight difference between main girders of old and new design is 2,300 lbs—about 37 percent of total weight reduction of entire trolley.



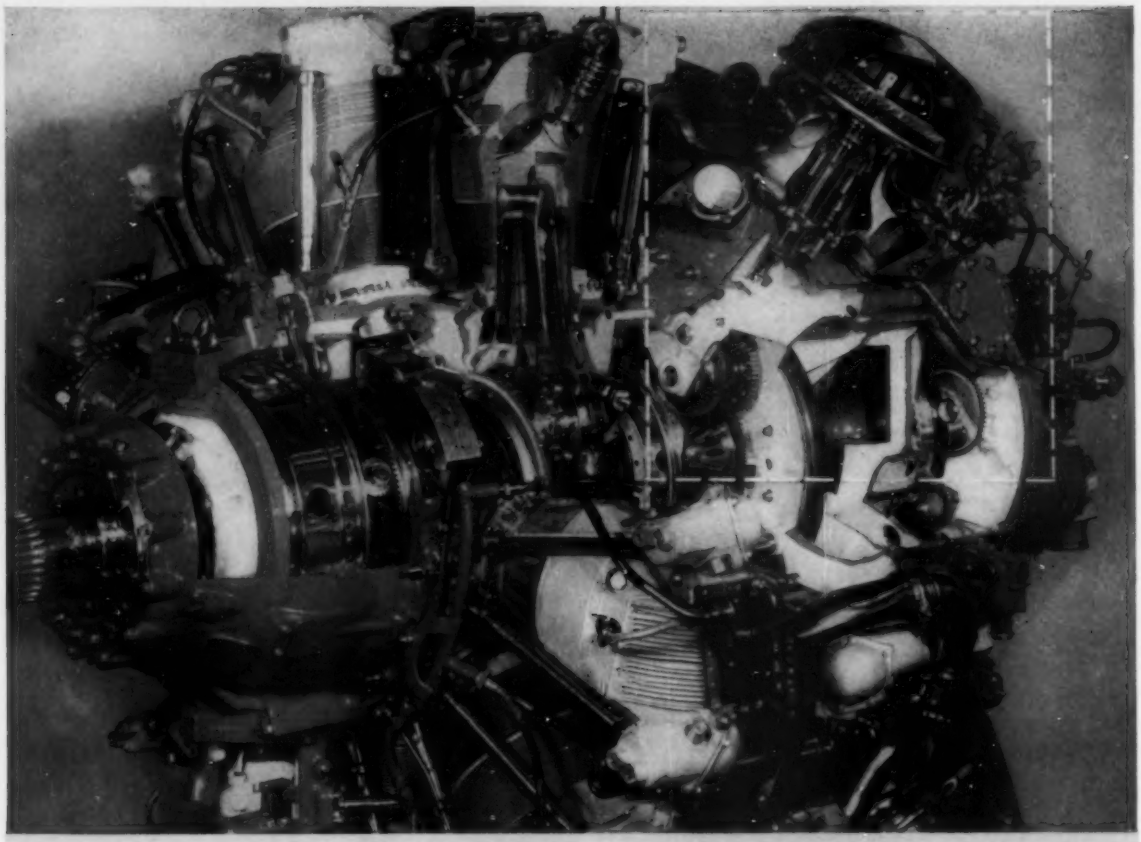


SUPPORTS FOR MOTORS and brakes (background) are of welded built-up construction making them integral with the main frame. To secure motor and brake support beams to the cross beams on the main frame, which are covered by checkered floor plate, 1 in. dia plugs welds were used. This carries tension loads directly into the flanges of the cross beams.

HOIST DRUMS, right, shown assembled to drive gears and the main shaft, are also welded. Each drum shell is made from two rolled halves, welded longitudinally. Drum ends are prefabricated and welded to the shell. Compared to old cast steel drums, new units weigh 200 lb less and take 2,100 lb of additional line pull.



TYPICAL ALL-WELDED bearing stand permits selection of the proper type and size bearing for each installation. The housing is burned down from a mild steel slab approximately 1 in. thicker than the bearing width. After welding feet and stiffeners, bearing stand is bored to the correct O.D.



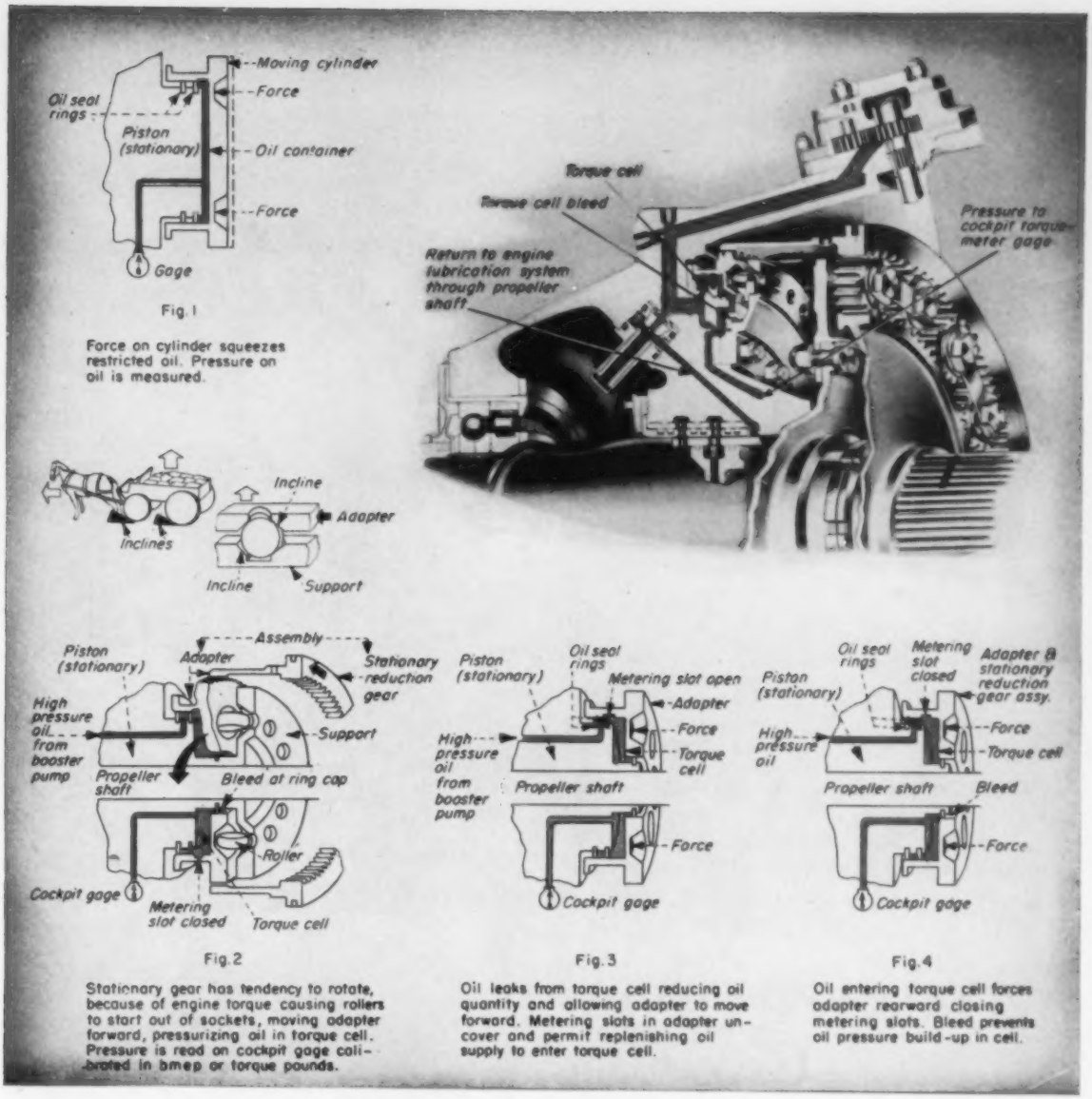
Design Highlights in Turbo-Compound Engine

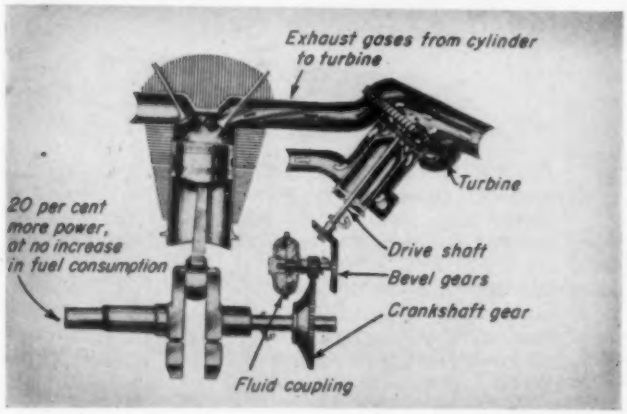
Cutaway view of the Curtiss-Wright Turbo Compound, first commercial use of which is powering DC-7's non-stop, Coast-to-Coast in under 8 hours. Going one step further in narrowing the gap between a conventional reciprocating plant and a turbo-jet, it employs a power recovery system to convert the energy in exhaust gases into available shaft horsepower, a factor sufficient to boost take-off power by 500 hp. Another feature is the torquemeter design to measure the actual engine power output. Note the boxed-out section on the engine cutaway—it was *Product Engineering's* cover for March, 1953.

• • • An interesting news item which could be a portent to the role of the Turbo Compound in the future plans of U. S. airlines is Capital Airlines' recent purchase of three Vickers-Armstrong turboprop Viscounts with options for 37 more.

• • • Aviation Week reported one interesting comment on the purchase. It quoted a long-time Washington observer as saying: "I'm glad to see the Viscounts get into this country. Maybe it will wake up U. S. manufacturers to the need for a real civil transport aircraft. Every plan we've received so far originally has been designed for the military; all we get is a modification of the military version".

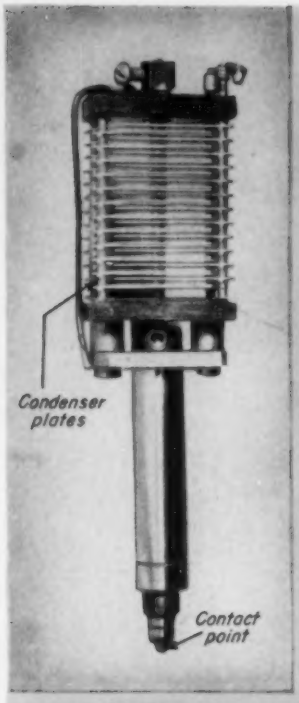
• • • From Capital's viewpoint, a big factor in the purchase was the fact that while the four Rolls-Royce Dart turboprops can power the Viscount at a cruising speed of 335 mph, vibrationless performance will have a strong passenger appeal. Also, standardizing on one type ship will ease maintenance.



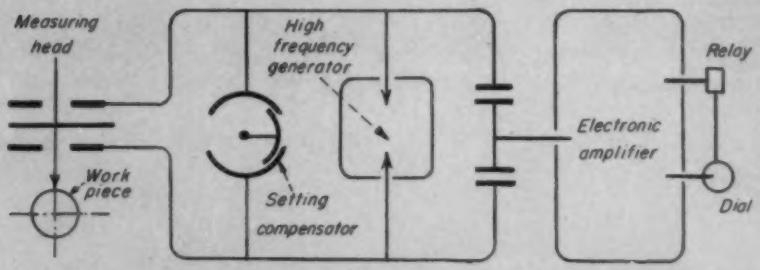


TORQUEMETER is located in the crankcase front section and ties in with the engine's reduction gearing system, the stationary reduction gear being utilized as the start of the torquemeter's action. Shown are a cutaway of the torquemeter assembly and Figs. 1-4 which explain its operation.

SCHEMATIC of the power recovery system which uses the velocity of the cylinder exhaust gases to drive a turbine. Power developed by the turbine is transmitted through a turbine wheel and quill shaft to a set of bevel gears and through a fluid coupling to the main crankshaft gear. Installed, the turbines are mounted 120 deg apart, one for each group of 6 cylinders.



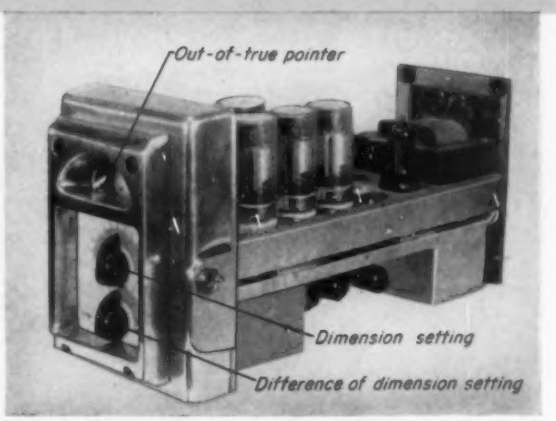
MEASURING HEAD consists of a meshed stack of Dural plates—separated from each other—but grouped together in a parallel-series arrangement to form two measurable capacitances. With any displacement of the contact rod, the plates are moved relative to each other thereby varying the capacitances in opposite directions. Then, by measuring the different ratios set up by the capacitances, the part measurement is obtained. Since such factors as moisture, temperature, ionization and transverse play have the same effect on both sides of the condensor plates, any errors are constantly cancelled out and do not affect the ratio of capacitances or measurement. Also, multiple plates are used to insure cancellation of any additional errors caused by feeder line inductance and capacitance influences as well as mechanical irregularities in condensor plate alignment.



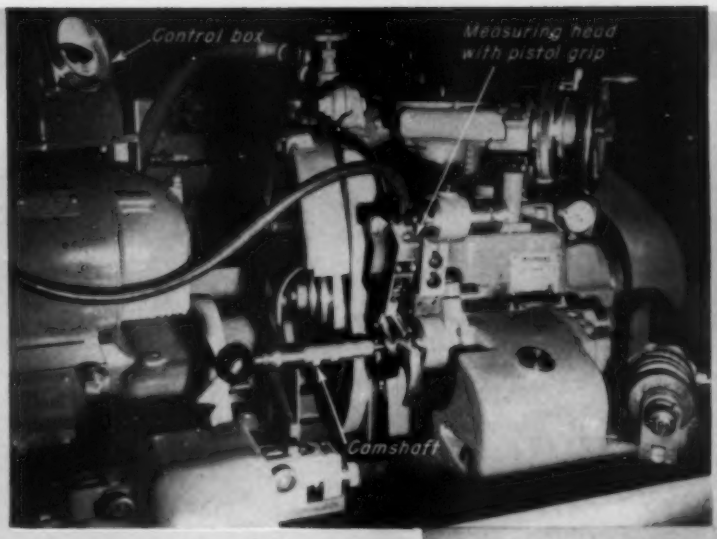
SCHEMATIC CIRCUIT DIAGRAM of the equipment illustrates the mechanical application of the "zero" principle of measurement. The compensator unit is used to set up the wheatstone bridge circuit for balance at the exact moment when the part is at the size desired. The high frequency generator energizes the stack of condensor plates which determine the ratio of capacitances. Thus, displacement of the plates corresponding to any out-of-size of the part creates a current to the amplifier to lock in the final measuring stage. However, maximum current is obtained only at a balance of the bridge to actuate any external relay.

Varying Capacitances Give Gage High Sensitivity

One of the latest steps in the progress being made toward using readings of dimensions to automatically control a machine's cycle and to readjust for necessary variations is an electronic comparator developed by E.A.M., Clamart, France. Accuracy of this device is one micron. Because the measuring unit is designed to withstand violent shocks, the gage can be adopted for many production operations. Agents in this country for the Stop Cote unit is the Electro-Autosizing Machine Co., New York, N. Y.

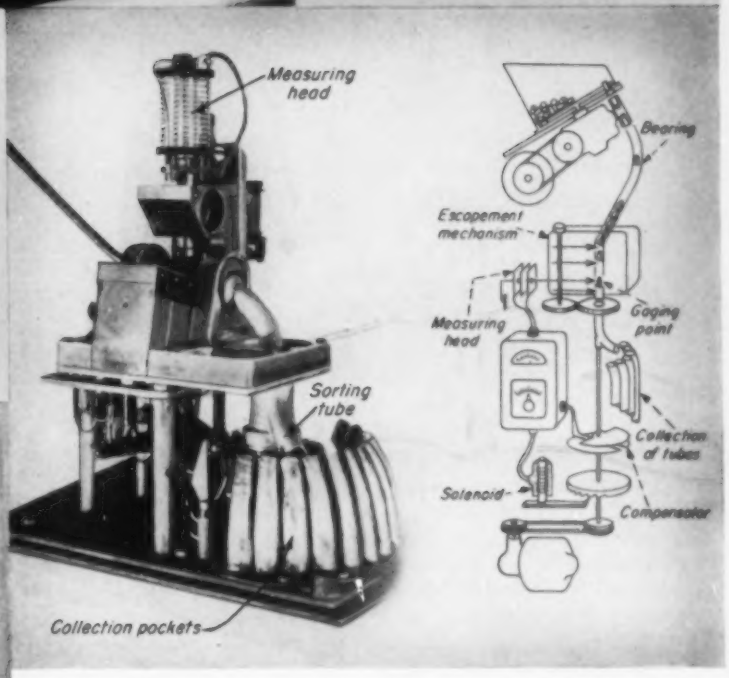


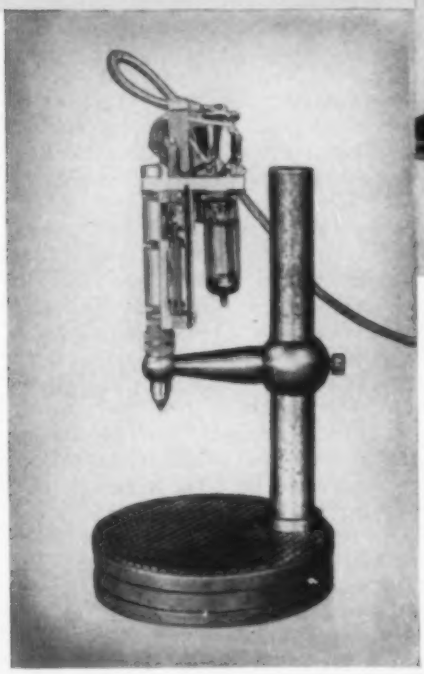
AMPLIFIER BOX contains an impedance-capacitance bridge circuit, a symmetrical oscillator of two high frequency stages and plate-curve detection and inverse d-c stages. Function of the equipment is to accurately translate the displacement of the contact rod into precise values of current, which, when rectified and amplified, becomes a maximum at the instant the bridge becomes perfectly symmetrical. This maximum current, in turn, can then be used to actuate a relay to operate machine components, or a solenoid for those machines using hydraulic controls.



AUTOMATIC SIZING, as shown here in conjunction with the grinding of a small camshaft, is one of the important applications for the Stop Cote device. Once the exact size of the part has been set into the amplifier box, decreases in dimension of the part cause an inverse variation in the two capacities. When the exact size is obtained, the capacitances show two equal values corresponding to the "zero" of the bridge. At this point, a relay is actuated to withdraw the grinding wheel from the work.

RECENT DEVELOPMENTS in electronic design enable the gage to be compactly constructed for general shop use, at a relatively low cost for comparators of this type. A single tube fulfills three functions: oscillator generator, detector and d-c amplifier. Condensor elements are designed to displace as fan blades. While same stability of measurement is maintained as with stack arrangement, sensitivity is increased.





AUTOMATIC CLASSIFYING is another operation around which the electronic gaging device is being successfully adapted. Figure above shows both a picture and schematic diagram of a unit currently being used to sort tapered roller bearings into 12 classes within a total range of 3 mm at sorting speeds up to 7000 pieces per hour. Schematic diagram shows bearings being fed to an escapement mechanism which momentarily holds each piece for measurement. For each measurement, the condensor plates in the measuring head set up a particular ratio of capacitances which when combined with a definite compensator capacitance effects a "zero" bridge balance for actuation of a relay. In operation, the upper compensator plate is continuously scanning the lower plate for the position creating a zero balance for the part being measured. When this occurs, the relay is energized locking the sorting tube over the proper classification pocket.

FLEXIBLE EPOXY PLASTICS

What Are Epoxy-Polysulfide Resins?

	Epoxy Resins	Polysulfide Polymers
Form	Liquid	Liquid
Solid conversion	Catalyst addition, heat optional.	Catalyst addition.
Major advantages	Chemical resistance. Good dielectric properties. High degree of adhesion.	Low shrinkage. High degree of impermeability to gas, moisture, organic liquids. Resistance to solvents, aging, weathering, ozone.
Producer	Bakelite Company Borden Company, Chemical Div. Ciba Products Company Shell Chemical Company	Thiokol Chemical Corporation

Modified epoxy resins constitute new class of flexible thermosetting plastics. High degree of impact and chemical resistance, low shrinkage, and good adhesion to metals and non-metals are major advantages. Developing fields of use: castings and embedments in electrical components and glass fiber laminates.

J. S. JORCZAK and D. DWORKIN
Thiokol Chemical Corporation
Trenton, N. J.

EPOXY RESINS have now reached the development stage where modification is extending their application range. This modification is aimed primarily at improving mechanical and physical properties—higher impact strength, a wider range of resistance to temperature cycling, lower shrinking, less residual stress, and higher bend and peel strengths in adhesion. One modification with which these improvements are attained combines epoxies with polysulfide polymers, to produce a series of flexible thermosetting plastics. Retained in the resulting combination are the good dielectric characteristics and chemical resistance inherent in the parent materials.

As potting and embedding compounds, these modified resins impart improved heat and mechanical shock resistance to electronic components. In glass fiber laminates, the lower viscosity of the epoxy-polysulfide combinations improves resin penetration of cloth or mat, and "wetting" of the glass fibers. Formulated into adhesives, the modified resins offer a combination of tensile shear strength, moisture impermeability and chemical resistance required for bonding of aluminum honeycomb structures. These adhesives are also suitable for joining other metals, plastics, glass, rubber or composites of these materials.

While epoxy-polysulfide materials are expensive, the production methods for these materials are not. Since all ingredients are liquid, simple mechanical mixing is the only major processing requirement. For complete cure of the parent materials, an amine catalyst is added. Depending on type of amine and epoxy resin, complete co-reaction can be obtained at room temperature. To develop maximum properties, post-curing of 1 to 6 hr at 140 to 250 F, or room temperature aging, may be required.

Liquid epoxy resins have a total volume shrinkage of 2 percent during the gel stage of their cure, and another 2 percent during final cure. Total shrinkage of epoxy-polysulfide materials is lower; in a resin proportion of 40 percent epoxy and 60 percent polysulfide, shrinkage is only 2 percent maximum. With the addition of such fillers as silica and aluminum flakes, shrinkage can be reduced even further.

Stress cracking is frequently caused by heat generated during the cure which converts such resins as epoxies from a liquid to a solid. This "exothermic" heat usually reaches a temperature of 300 F. With the poly-

Table I—Impact Resistance of Epoxy-Polysulfide Resins

(Data determined by Free-Falling Ball Method, M IL-C-16923 Ships, on 2 x 2 x 1/2 in. specimens, cured 48 hr at 80 F).

Catalyst, 10 per cent	Post-cure		Test Temp, F	Impact Resistance, ft-lb								
				Ciba CN-503			Shell Epon 828			Bakelite BR-18794		
	Temp, F	Time, Min		Unmod	Mod* 1:2	Mod* 1:1	Unmod	Mod* 1:2	Mod* 1:1	Unmod	Mod* 1:2	Mod* 1:1
Triethylene-tetramine (Carbide & Carbon Chemical Co.)	(None)		80	1.0	78.0**	78.0	1.3	47.0	78.0	3.3	67.0	78.0
			−35	1.1	2.9	4.0	0.3	2.5	3.5	1.5	2.5	12.0
DMP-30 (Rohm & Haas Co.)	—	—	80	0.4	0.7	78.0	0.5	1.1	60.0	0.7	2.5	77.0
	212	30	80	0.3	0.9	—	0.5	2.3	—	0.6	4.3	—
	212	60	80	0.9	6.8	—	6.7	4.3	—	2.3	6.3	—
	212	90	80	2.8	12.6	—	7.1	7.3	—	3.0	8.3	—
	—	—	−35	0.2	0.4	1.1	0.3	0.5	1.3	0.4	1.3	1.9

* Polysulfide-Epoxy Ratio.
** Maximum value obtained with test equipment; actual values are equal to or greater than those shown.

sulfide modification this temperature is lowered by more than 100 F, reducing localized stress concentration in the part, and lessening the possibility of damage to heat-sensitive components.

Epoxy-polysulfides display good impact resistance, even at low temperature. Apparently, lowered cure shrinkage and flexibility imparted by the polysulfide component reduce brittleness and consequent shock failure, particularly at low temperatures. Impact resistance of unmodified epoxy resin at −35 F, for example, ranges from 0.2 to 1.5 ft-lb, depending on type of epoxy in the formulation. However, impact resistance at −35 F of modified epoxy, cured under the same conditions, ranges from 2.5 to 2.9 ft-lb. Room temperature impact resistance comparisons are considerably more striking, Table I. Where impact resistance for unmodified epoxy is only 1.0 ft-lb, the value for the modified material is 78 ft-lb. The large difference is a direct effect of the polysulfide modification, and, as can be seen from Table I, depends not only on the amount of polysulfide, but also on the type of epoxy, and type of catalyst used in the cure.

Table II—Moisture Vapor Transmission of Epoxy-Polysulfide Resins

(Oz-ft per sq ft at 24 hr, determined by ASTM Method DB14-46 T, 10 per cent DMP-30 Catalyst; cured 48 hr at 80 F).

Epoxy Resin	Moisture Transmission, oz-ft per sq ft in 24 hr		
	Unmodified	Modified* 1:2	Modified* 1:1
CN-503	0.136	0.045	0.009
BR-18794	0.162	0.037	0.004
Epon 828	0.057	0.057	0.008

* Polysulfide-epoxy ratio.

Moisture vapor transmission is lower in modified epoxies than it is in unmodified formulations, Table II. In 24 hr, moisture vapor transmission for modified is 0.037 oz-ft per sq ft; for unmodified, 0.162 oz-ft per sq ft.

The water absorption on total immersion varies with the type of amine used for curing, the structure of the epoxy resin, and the state of cure of

Table III—Physical and Electrical Properties of Typical Potting and Casting Compounds

(Epon 828 resin, Polysulfide LP-3; 10 per cent triethylene tetramine catalyst).

Property	Unmod.	Modified*	
		1:2	1:1
Physical**			
Tensile strength, psi	3,500	2,300	1,700
Elongation, per cent	0	30	40
Hardness, Shore D	85	50	40
Electrical***			
Dielectric constant, 1 kc	3.8	3.8	5.1
Dissipation factor, 1 kc	0.004	0.006	0.017
Dielectric strength, v/mil	400–500	400–500	400–500
Volume resistivity, ohm-cm	8×10^{16}	6×10^{12}	9×10^{12}

* Polysulfide-epoxy ratio.
** Properties were same for specimens conditioned for 24 hr at 80 F and for 3 days at 212 F.
*** 77 F and 50 per cent RH.

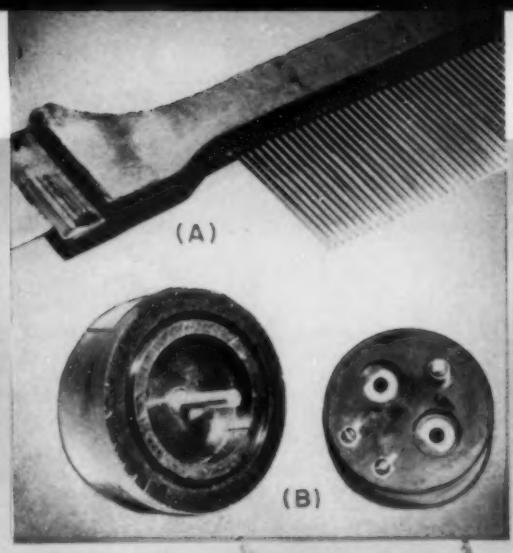


Fig. 1—Castings and embedments are major applications for new flexible epoxies. Textile comb (A), which incorporates epoxy-embedded steel teeth, is used to remove iron filings, dirt and other foreign matter from wool before spinning into cloth. Durable cast potentiometer components (B) are produced by Nureco Inc.

the combination. With some resins, the trend is for higher water absorption, whereas with others, lower water absorption is obtained. With 1:2 ratio of epoxy and polysulfide, the water absorbed after several weeks of immersion varies from about 0.5 to 6 percent.

Resistance to chemical attack is a major advantage of epoxy-polysulfides. After 30 days total immersion, they are unaffected by such inorganic acids and salts as hydrochloric acid, sulfuric acid, caustic soda, saturated sodium carbonate, and saturated aluminum sulfate. They also display good resistance to organic solvents.

In addition to imparting built-in flexibility, polysulfide reduces the viscosity of most liquid epoxy resins. This permits easier handling and pouring into intricately shaped molds and better penetration into the interstices of parts being embedded, Fig. 1. Lower shrinkage and less residual stress are developed during casting.

Reduction of maximum cure temperature permits casting of larger volumes with closer control. Reduced residual stress and flexibility, therefore, permit embedment of delicate assemblies which can withstand greater mechanical and thermal shock. Since the epoxy-polysulfides aid in the "wetting" of many metallic and ceramic surfaces, adhesion is better than with straight resin. However, as shown in Table III, tensile strength is not as great as that of straight resin. Elongation increases and shear hardness is less. In addition, the modified compounds do not corrode copper or steel.

In low pressure laminates with glass fabric, glass mat and glass roving, Fig. 2, epoxy-polysulfides exhibit improved penetration and wetting. The flexibility of the resin permits formation of molded parts with very low shrinkage and residual stress. The impact resistance is also improved, Table IV. In one test on fiber glass pipe, Fig. 3, it was found that although the use of unmodified resin yielded higher strength at burst pressure, "weeping" occurred at stress points at approximately 10 per cent

Table IV—Physical and Electrical Properties of Typical Epoxy-Polysulfide Laminates

(Prepared with Epon 828; DMP-10 catalyst; 181–114 glass cloth; laminate consisted of 12 ply for 1/8 in., 48 ply for 1/2 in.; total resin content 20–28 per cent; tests conducted on 1/8 in. specimens; compression conducted on 1/2 in. specimen).

Property	Unmod	Modified*		
		1:4	1:2	1:1
Physical				
Flexural strength, psi x 10^3 Room temp (dry)	55	63	50	10
After 2 hr in boiling water	50	32	8	—
Modulus of elasticity in flexure, psi x 10^6	3	3.4	—	—
Impact, ft-lb, Izod	11	12	15	16
Compressive strength, edgewise, psi x 10^3	30	33	27	17
Electrical**				
Dielectric constant,				
10^3 cps	4.4	4.7	5.0	5.2
10^6 cps	3.6	3.8	4.1	4.2
Loss factor,				
10^3 cps	0.002	0.003	0.0035	0.0040
10^6 cps	0.021	0.014	0.0190	0.0230

* Polysulfide-epoxy ratio.
** 77 F and 50 per cent relative humidity.

Fig. 2—In aircraft and related applications, high impact strength of flexible epoxies is prime requisite. (Right) glass cloth, canvas and aluminum honeycomb impregnated and bonded to aluminum with Borden's epoxies.

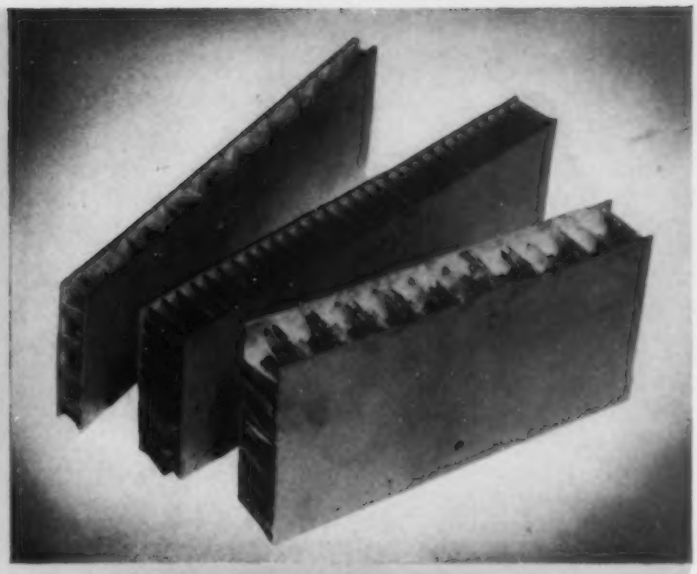
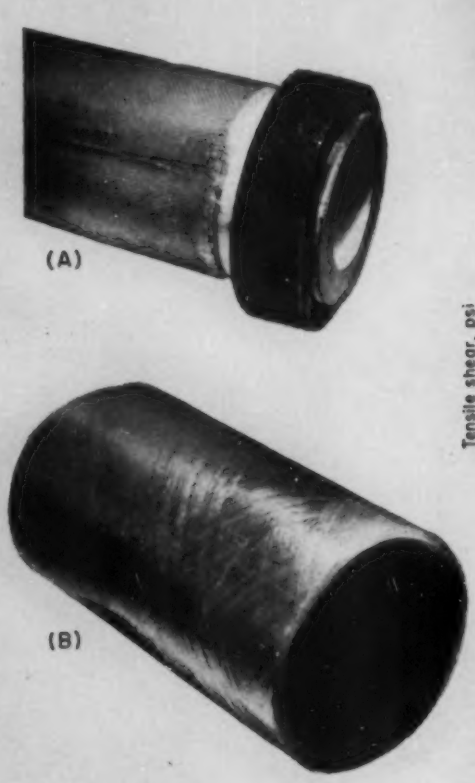


Fig. 3—Chemical resistance, high impact strength and "non-weeping" exhibited by epoxy laminates promote their use in pipe and ducting. (A) flexible epoxy bonds three materials—ceramic liner, cast iron fitting and glass fabric—in this one pipe unit. (B) mandrel-produced tubing section, consisting of glass fibers, impregnated and molded—laminated with flexible epoxies.



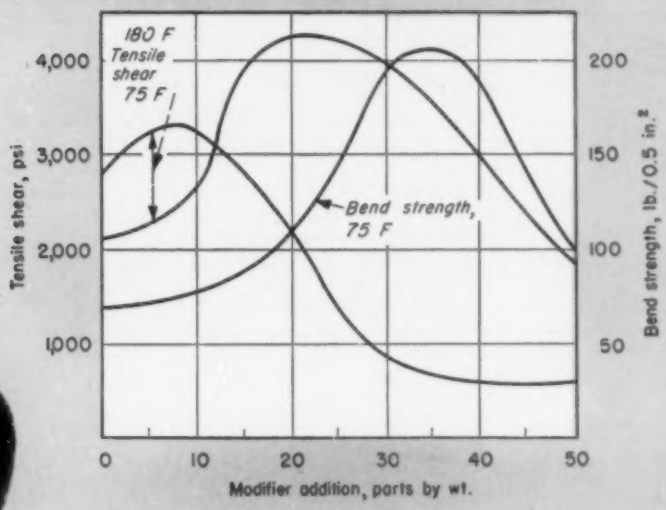


Fig. 4—Modified epoxies such as Borden's modified Epiphen possess 3 to 4 times greater bend strength than unmodified formulations. Tensile shear also increases but drops if modification contains more than 20 per cent polysulfide liquid polymer.

of the ultimate pressure. The modified resin resulted in a lower burst pressure, but no weeping was noted during the test.

In adhesives, good shear strength can be obtained with room temperature cures. Modified epoxy adhesives containing about 20 to 25 per cent polysulfide improve the bend strength of adhesives by three to four times. However, after reaching a peak, Fig. 4, tensile shear and bend strength will decrease if the polysulfide modification is excessive. A major disadvantage of the epoxy-polysulfide adhesives is lowered heat resistance; they are generally not recommended for service temperatures exceeding 150 F. However, commercial adhesives based on epoxy-liquid polymer resins have been developed with shear strengths in excess of 1,200 psi at 180 F. Borden reports that their Epiphen adhesive withstands 2,400 psi. The thermal shock and impact properties of these adhesives are improved over a wide range, especially at low temperatures.

Rubbing Seals for Oil

Rubbing seals cover all applications where a positive sliding contact exists between the seal and either the rotating or stationary member. They are limited as to useful operation and speed because of the friction between the contacting surfaces and they should not be used in abrasive

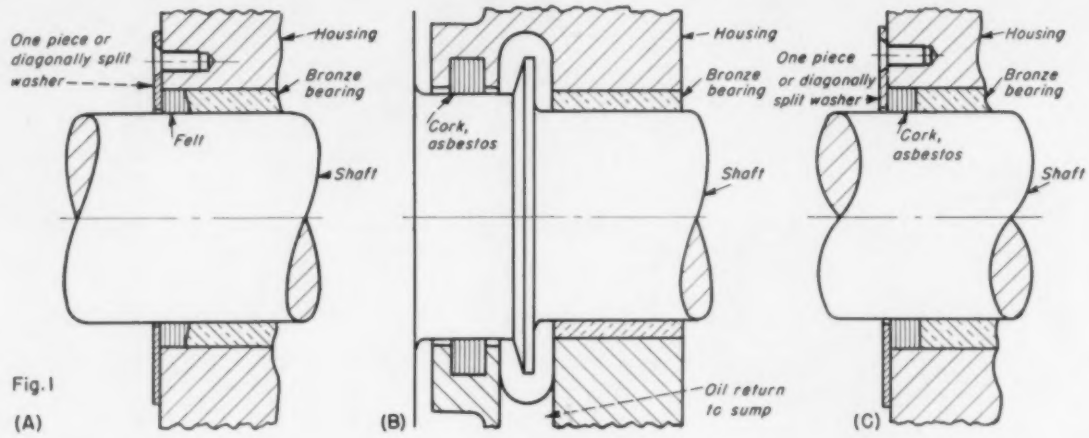


FIG. 1—Rubbing seal for oil lubrication. Felt, cork, asbestos, natural or synthetic rubber or other materials can be used. The natural resiliency of felt provides a close contact between seal and shaft without the excessive pressures often encountered with other types. It also absorbs and retains oil providing for almost constant lubrication. For the retention of felt, design A is recommended, because the tapered sides insure close contact and the removable plate permits easy replacement. (B) and (C) may also be used. Cork and asbestos should be retained as shown in (B). Groove must be straight sided and narrow enough to compress the material slightly to prevent it from turning.

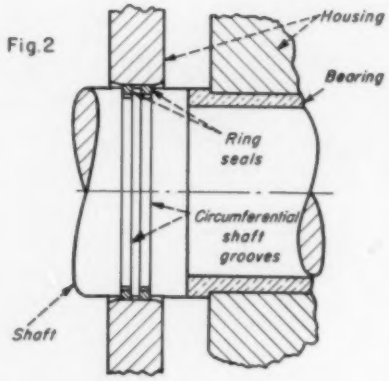


FIG. 2—Bronze or cast iron rings are frequently used to seal bearings. This type of seal is equally effective for reciprocating and rotary motion. Circumferential grooves are cut in the shaft and the rings are compressed and inserted. They bear on the housing effectively sealing in the lubricant.

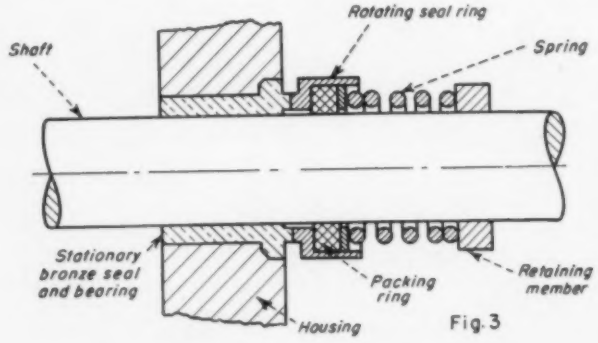


FIG. 3—High pressure and high rotative speeds where leakage is critical use mechanical face type seals. The seal has low total friction, can withstand high misalignment and compensates for wear. Parts of the seal are: stationary seal ring, rotating seal ring, flexible type joint, (diaphram, bellows, or packing ring) spring, and retaining members. The stationary member can be an integral part of the bearing when a cast bronze sleeve bearing is used. As illustrated, the rotating seal ring, packing spring and retaining member turn with the shaft and the spring keeps the seal ring in contact.

Retention

DAVID C. SPAULDING, JR.
Product Engineer, The Bunting Brass and Bronze Co.,
Toledo, Ohio

surroundings. Types that are held against the rotating member by spring pressure can be used where there is a pressure head of fluids within the assembly or on the exterior. For high pressure stuffing box and O-ring type seals are used. O-rings are also used for zero leakage.

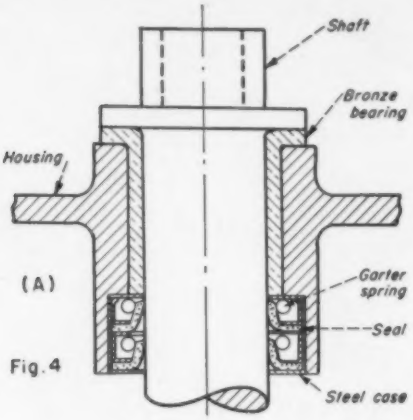


Fig. 4

FIG. 4—Rubbing seals, of the type shown, (A), have widespread use in all types of equipment. The spring tension and sealing ring material may be varied so that a variety of applicatoins can be handled. Small units can be had where the O. D. is the same as the O. D. of the sleeve bearing, (B), thus eliminating the counterboring operation on the housing. The seal may be reversed and used to keep foreign matter out of the assembly. A drain hole may be provided to carry away surplus lubricant. Retention is by press fit on the outside diameter.

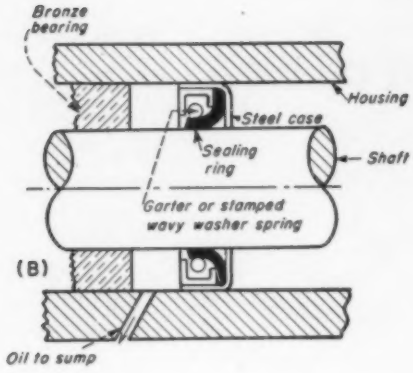


FIG. 5—Rubbing seals of the stuffing box type (A), are used where high pressures are encountered. It can be used for all types of motion and the packing material can be varied depending upon the fluid to be sealed and the application. For rotating motion some leakage is necessary so it cannot be used when permissible leakage is zero. O-rings can also be used for rotary motion if the speed is slow. Special designs use O-ring type seals (B), when zero leakage is demanded for either stationary or reciprocating motion.

This ring is made of natural rubber or synthetic rubber depending on the type of solution resistance required. Synthetic rubber, such as buna or neoprene, is resistant to aromatic hydrocarbons, while natural rubber resists the action of alcohol and glycerine.

O-rings can be located either in the shaft or in the housing and any movement or pressure forces the ring to one side, thereby forming a tight seal.

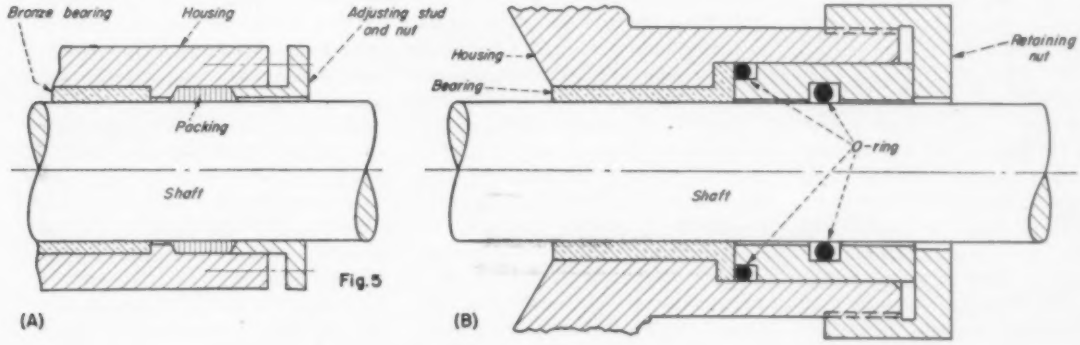


Fig. 5

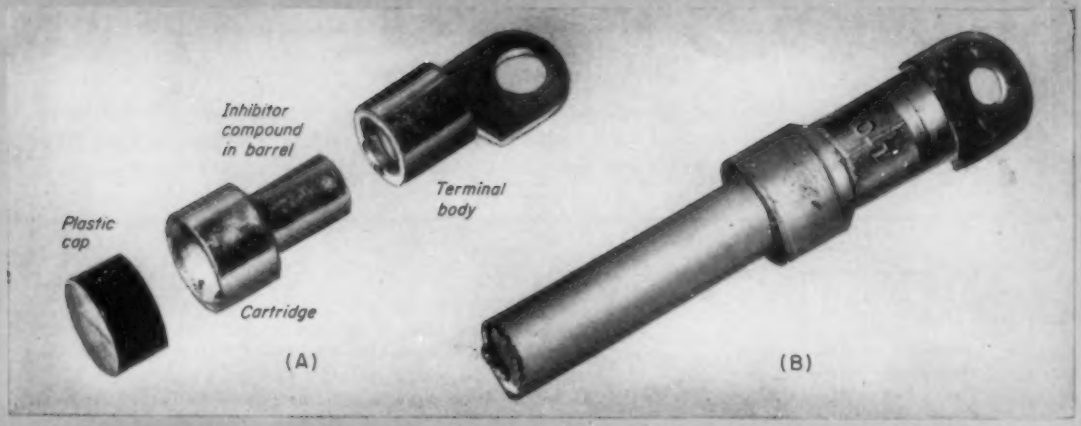


Fig. 1—New aluminum-conductor termination for aluminum-to-aluminum or aluminum-to-copper connections. (A) Components are: (1) Hollow cartridge with one open end; (2) inhibitor compound of metal powder suspended in petrolatum fills barrel and provides proper oxide cleaning and sealing; (3) terminal body into which cartridge barrel and conductor are inserted and crimped; and (4) plastic cap which seals cartridge against loss of inhibitor compound.

Compression Terminals for Aluminum Conductors

New compression terminal provides low-resistance, corrosion-resisting, aluminum-to-copper connections. Creep and thermal expansion of aluminum are controlled in connector which can be used with production tooling.

J. REDSLOB
Chief Project Engineer
Aircraft-Marine Products, Inc.

USE OF ALUMINUM instead of copper for electrical conductors offers opportunity for reduction in cost and weight. An aluminum conductor of the same conductivity weighs half as much as copper. In addition, the base cost of the lighter metal is only about 70% that of copper. One of the problems in the use of aluminum conductors in electrical products has been a suitable means of splicing and terminating. Aluminum-to-aluminum or aluminum-to-copper joints have been difficult and costly to solder or braze. Some types of compression terminals have been used but only with moderate success. The requirements for a compression terminal for aluminum wire are: (1) It must break down the high-resistance oxide film on the aluminum and prevent its re-formation; (2) prevent electrolytic (galvanic) corrosion of the conductor; (3) prevent chemical corrosion of wire strands; (4) compensate for the higher creep rate and thermal expansion of aluminum as compared to copper; (5) provide a crimp which produces uniform contact pressure between the termination lug and conductor; and (6) provide sufficient area for heat dissipation combined with enough cross-sectional area for proper conductivity.

The oxide film, which rapidly forms on a clean aluminum conductor exposed to air, is hard and has high electrical resistance. If the oxide is not removed when the conductor is terminated, current flow through the oxide produces heat. As joint temperature rises the ovide film thickens, further increasing the resistance and producing more heat. This regenerative process soon causes terminal failure.

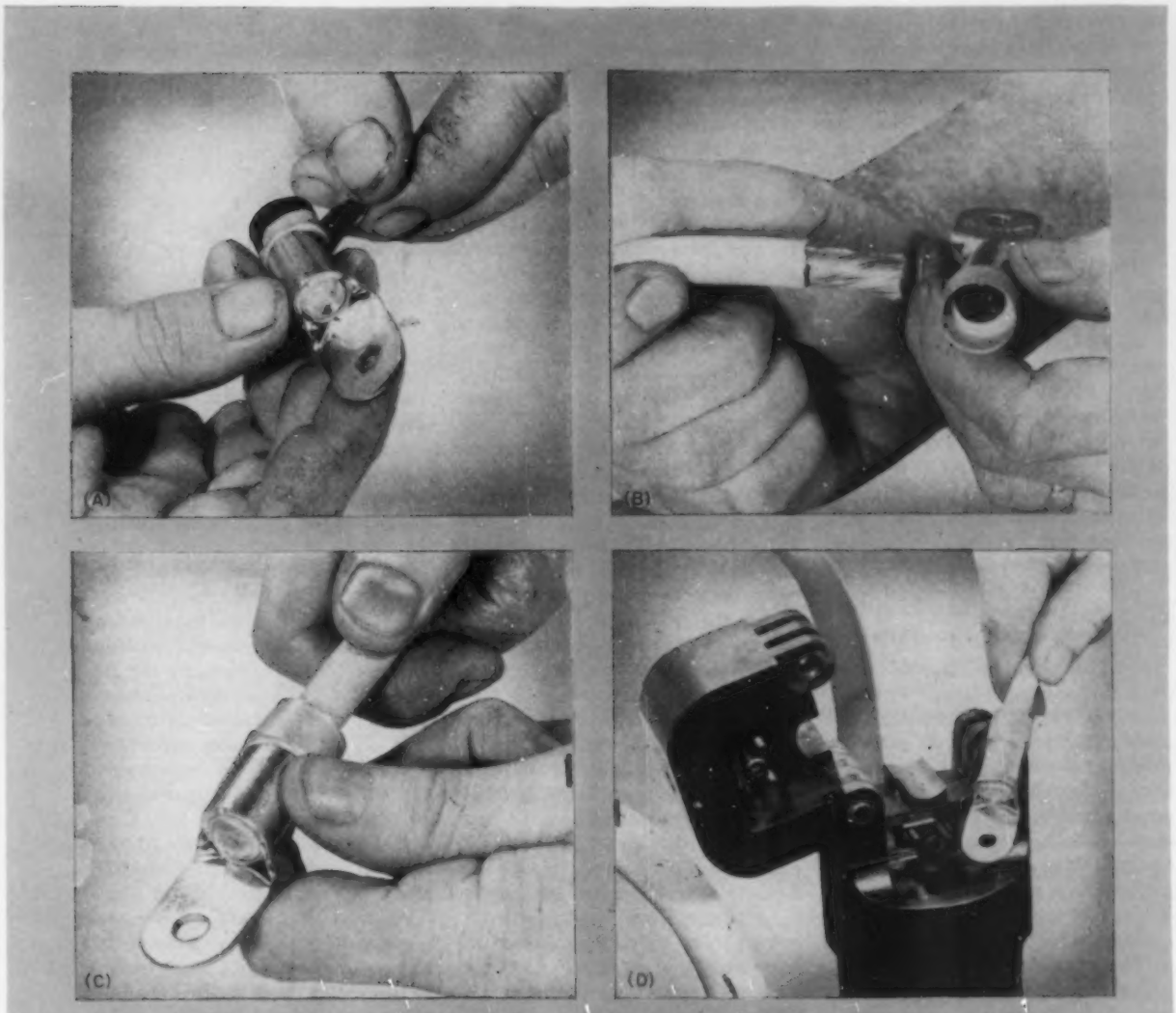


Fig. 2—Steps in making termination. (A) Removing plastic cap. (B) Prepared conductor ready for insertion in cartridge barrel. (C) Conductor inserted. (D) Termination crimped by hydraulic tool.

Aluminum is the most chemically active of conductor materials. If an aluminum wire is crimped in a copper barrel and the joint is exposed to humidity, a galvanic cell forms. The aluminum rapidly deposits itself across the joint onto the copper; and after a period of exposure the terminal and the crimped portion of the wire may break away from the main conductor.

Aluminum terminations have caused failure in cables, as far back as 18 in. from the terminal. In this instance moisture is drawn into the wire strands by capillary action, either through or immediately back of the crimp. The moisture in the cable, in absence of oxygen, reacts to form aluminum hydroxide which initiates and promotes corrosion of the individual strands. As each strand parts, additional current must be carried by the remaining strands, increasing the temperature and chemical activity at that point; failure finally occurs.

Creep rate, or the amount which aluminum relaxes under pressure, is a function of temperature and stress. The creep rate of aluminum is considerably greater than that of copper for the same temperature and stress. To overcome this problem the residual stresses in an aluminum termination must be kept down to $\frac{1}{4}$ to $\frac{1}{2}$ that usually obtained in copper connections. Such reduced contact pressure, if not compensated for in some manner, increases the danger of poor electrical contact and terminal heating, with consequent failure.

The difference in thermal expansion of copper and aluminum, for the same temperature rise, affects a connection made with a copper barrel on an aluminum wire. If heat is generated in the joint due to (1) ineffective oxide removal, (2) lack of adequate cross-sectional area in the tongue of the

connector, or (3) excessively high ambient temperatures maintained over an extended period of time, the aluminum conductor expands more than the barrel. When the connection cools, the wire shrinks. On following heat cycles the reduced internal contact pressure produces a higher resistance, generates more heat, and increases the chances of ultimate terminal failure.

When the indent-type crimp is used with compression aluminum terminations, stresses are set up in the strands immediately surrounding and beneath the indent. Those strands in the upper portion of the crimp on either side of the indent are compressed considerably less. As a result, there is ineffective cleaning between strands at low-compression points of the crimp, lack of sufficient low-resistance contact area, and "hot spots" at the high-compression points of the terminal.

New Terminal Solves Major Problems

New aluminum termination developed by Aircraft-Marine Products, shown in Fig. 1, is a two-piece terminal suitable for use with either an aluminum-to-aluminum or aluminum-to-copper connection. These terminals are designed to provide proper oxide cleaning, sealing, and crimping. In addition, adequate surface and cross-sectional areas maintain the connection at lowest operating temperature.

The AMP terminal has three essential features shown in Fig. 1A: (1) A hollow cartridge with one open end into which the conductor is inserted; (2) an inhibitor compound which fills the barrel of the cartridge; and (3) a terminal body into which the cartridge and conductor are inserted and crimped. The cartridge, made of commercially pure aluminum alloy, contains no copper or foreign elements which could cause intergranular electrolytic corrosion. The cartridge functions to provide good contact between the barrel of the terminal body and the aluminum conductor. The inhibitor compound is a metal powder suspended in petrolatum jelly. A plastic cap, shown in Fig. 1A, seals the open end of the cartridge against loss of inhibitor during storage or handling.

The procedure for making a termination is shown in Fig. 2. The plastic cap is removed and the stripped end of the conductor inserted in the barrel. The end of the conductor exerts pressure on the inhibitor compound, forcing it between the conductor strands and between the conductor and cartridge wall. During the crimping operation the inhibitor is extruded back through the strands under high pressure, and abrasion produced by the metal particles cleans the oxide from the wires. When the crimp is complete as shown in Fig. 2D, the extruded petrolatum jelly seals the open end of the cartridge around the insulation and prevents the aluminum from becoming reoxidized. The seal also prevents moisture from creeping into the cable strands and producing chemical corrosion.

Two styles of terminal bodies are used with the aluminum cartridge. Both types have a large contact area in the barrel section to provide low electrical resistance at reduced pressures, encountered due to creep of aluminum.

One style of terminal body, sold under the trade name of Termalum, is an aluminum alloy of high purity and strength. It has been designed primarily for conecting aluminum conductors to aluminum bus bars. The terminal tongue is designed with suitable dimensions to give proper tensile strength and conductivity. These terminals are installed using washers equal in diameter to the tongue width, and preferably of cadmium-plated steel.

The second style of terminal body, sold under the trade name Copalum, is made from electrolytic copper, electroplated with tin. Dimensions of the copper tongue are smaller than an aluminum tongue of the same current-carrying capacity. Cold flow at the tongue end is no problem. This type terminal is primarily designed for applications joining aluminum to copper bus bars.

In using these copper terminal bodies the problem of thermal expansion must be considered, because the copper surrounds the aluminum conductor. For this reason, applications must be carefully analyzed where severe temperature variations or high current cycling are likely to occur during the life span of the terminal.

The crimp used for both types of terminal bodies is the confined "C" shown in partial cross-section in Fig. 3. This crimp increases the contact areas between the strands to a maximum and cleans them at the same time. Its symmetrical shape tends to deform all the wires uniformly, eliminating possible "hot spots" in the crimp.

Tooling for these terminations is designed with variable insulation-support adjustments to give adequate grip on various wire insulation diameters. Tools are of the hand-hydraulic or pneumatic-hydraulic variety because of the larger crimping pressures necessary in the 8 to 4/0 sizes of conductors. The crimping dies brand wire sizes on each terminal for inspection and identification purposes.

Both aluminum-to-aluminum and aluminum-to-copper terminations have undergone exhaustive tensile, corrosion, vibration, thermal shock, and temperature rise tests. These terminations exceed the requirements of Mil-T-7099B (Crimp Style Lug Terminals for Aluminum Aircraft Cable) and closely approach the requirements for termination of copper wire.

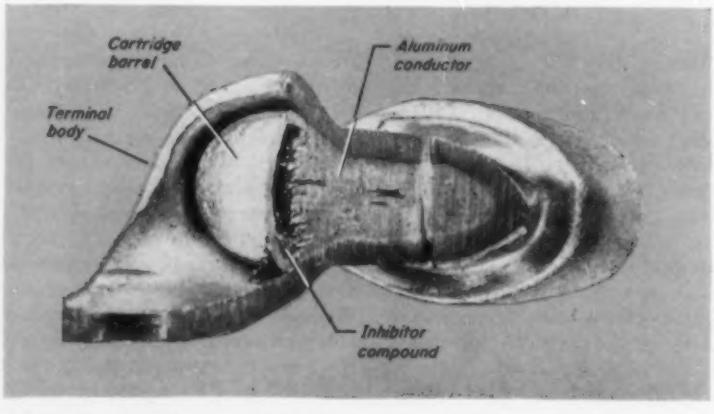
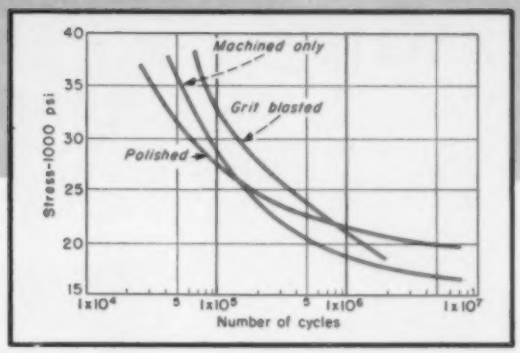


Fig. 3—Cutaway view of crimped termination showing confined "C" crimp which cleans strands and provides a maximum contact area between them.

Effects of Finishing on 75S-T6 Aluminum Alloy

M. J. BROWN
Senior Materials Test Engineer
The Glenn L. Martin Co.



TABULATED and graphically shown as three curves of stress vs. the number of cycles, the graph can be divided into four areas, and can be used as a guide to the selection of the right surface finish—shown in its relation to fatigue.

WHILE NEW ALLOYS are being developed to increase the strength-to-weight ratio of aircraft structures, more emphasis is being given to the problem of fatigue life. Aircraft must now withstand more severe service conditions, and these factors underlie the present efforts to retard the fatigue of structural metals.

In line with these efforts, is this test showing the comparison between the fatigue life of 75 S-T6 aluminum alloy in its as machined condition to the fatigue life of the same material when hand polished or grit blasted. The results of the investigation—plotted as curves above—are now being used as a basis for the selection of finishes, and should be useful in maximizing the endurance of 75S-T6, and in minimizing the costly polishing techniques in the finishing of structural parts.

Fifty specimens of $\frac{3}{8}$ in. thick bare plate were butt-milled to 0.250 inch. The surface quality was 120 rms, and both cutter marks and grain of the material were in longitudinal direction. The stress concentration factor was 1.16. The specimens were separated into three groups—the first in the as-machined condition; the second also machined, but additionally hand polished to a surface finish of 25 rms; and the third, after being machined, was grit-blasted, with the final surface quality being 120 rms.

The specimens were tested to destruction by axially applied loads in tension and compression. The test results are graphically shown as curves of stress vs. number of cycles. The graph can be divided into four areas. In each of these, a cross-over of the curves marks off a change in the relationship of surface finish to fatigue.

Aircraft ribs and skins, to which a slight addition of thickness would result in a penalty in weight, as a rule are highly stressed. These parts require a prediction of the stress and the number of repeat loads expected. If a rib has been designed to withstand 10^5 cycles under a load of 30,000 psi, the graph shows that the curve for the grit-blasted specimens alone lies above the intersection of the 30,000 psi and the 10^5 cycle lines. Only the grit-blasted finish, therefore, will withstand the predicted service conditions. The curve described by the as-machined specimen falls below the requirements for the part—and the costly hand-polishing operation would shorten, rather than extend its service life.

On the other hand, a wing root fitting may be strengthened with little proportional weight penalty, and thus stressed to a lesser value. If such a part must stand up under a load of 23,000 psi for 5 x 10^5 cycles, the choice would have to be made between the hand polished and the grit-blasted finish. In this area of the graph, both of the noted surface conditions are superior in fatigue life to the as-machined surface, but grit-blasting is obviously preferred because of its lower cost.

At 21,500 psi, another cross-over occurs. Here, the curve for the hand-polished surface crosses that of the grit-blasted finish, becoming the superior condition for 75S-T6 aluminum alloy.

Below 20,000 psi, the curves approach the endurance limit of the material for the tested surface conditions. This is the maximum degree of stress at which the material will take an unlimited number of cyclical loadings. The hand-polished specimens will take about 19,000 psi, while the as-machined group exhibits a lower endurance limit, and the grit-blasted material is comparatively poor.

Plaster Casting the Light Metals

GEORGE R. GARDNER
Assistant Chief,
Cleveland Research Division,
Aluminum Company of America

THE RANGE OF PARTS that can be cast from aluminum has been extended to many new applications by the development and perfection by Alcoa of a new foundry process based on plaster as the mold material. This plaster technique makes possible the casting of sections $\frac{1}{16}$ to $\frac{1}{8}$ in. thick having a surface finish of 125 micro-in. RMS or better. In addition, dimensional tolerances closer than those associated with sand and permanent mold methods can be achieved.

A typical application wherein these design features are capitalized is in bladed parts, such as the automotive torque converter casting shown in Fig. 1 wherein plaster cores are used to maintain blade tolerances and surface smoothness. Similarly, advantages are also to be gained in the large scale production of small parts where fine detail, smooth surface, close dimensional tolerance and freedom from flash are important. These benefits are obtainable in plaster without the large die or tool expense associated with die casting.

One of the most interesting design possibilities offered by the new plaster process centers around the use of composite molds. For example, three mold materials can be used to produce a single casting: plaster where smooth surface and close tolerances are important, iron and/or sand elsewhere. The designer can thus achieve near optimum surface condition, strength and tolerances at low cost.

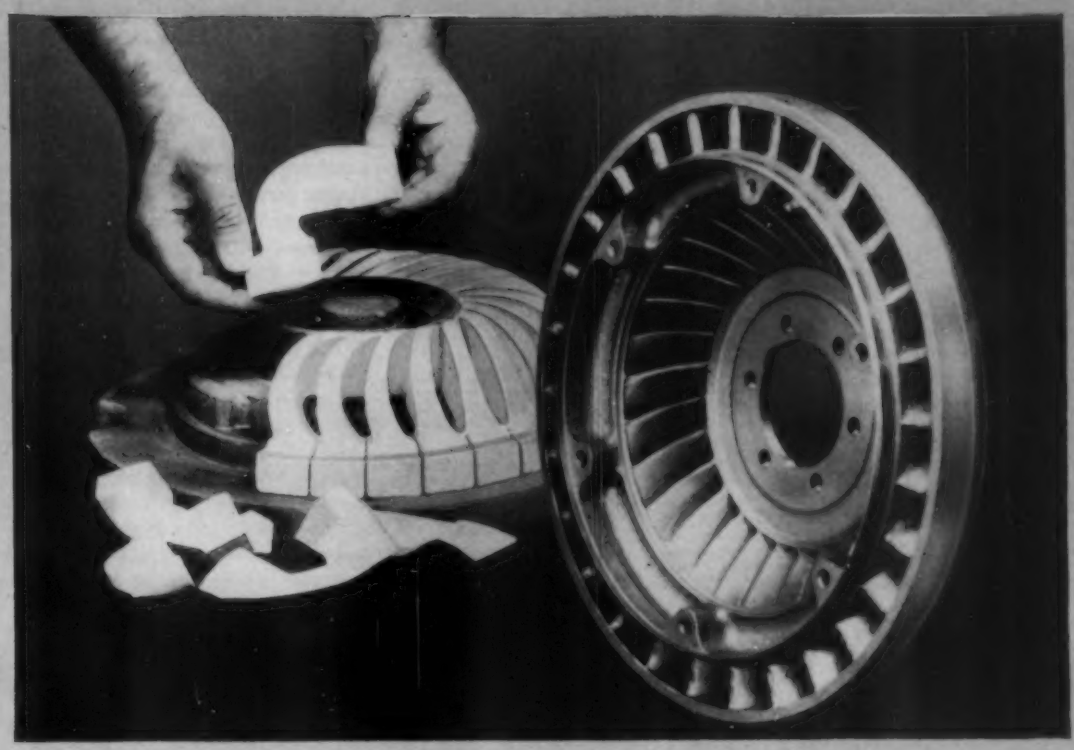


Fig. 1—Torque converter part made of SAE 326 aluminum alloy is cast in composite mold—outer ring in iron, center web against dry sand core, and vanes between outer and inner rings in plaster. Test bars machined from vanes had average tensile strength of 32,350 psi or 119 percent of minimum for separately sand-cast test bars.

The design potentials of aluminum and magnesium castings are greatly expanded, now that plaster is economically competitive with sand and iron as a mold material. Small irregularly-shaped and relatively large bladed parts with smooth-walled sections can be cast to very precise tolerances. Article covers casting design considerations, mechanical properties, finishes and applicable alloys.

The principal reason for using plaster is that, unlike sand, the plaster can be prepared as a liquid slurry and poured around a pattern or into a core box instead of being rammed into place. The plaster hardens around the pattern, permitting it to be withdrawn and handled as an integral, self-supporting body unlike that of sand molds which are a weak, friable agglomeration of particles. The phenomenon of a self-hardening liquid mold material accounts for the finer surface finish and improved accuracy obtainable in plaster.

Though a number of plaster processes have been used in the foundry industry, the particular technique developed by Alcoa is characterized by the high permeability of the plaster. This property is attributable to millions of tiny, interconnected pores or air spaces which promote the escape of gases generated when molten metal is poured into the mold. When ready for pouring, plaster molds have a relatively low density and a highly porous structure consistent with their high permeability values. As a result of the cellular structure, the plaster mold material is also a good heat insulator. This characteristic permits the pouring of much thinner sections than is possible in the more conventional sand or iron molds which have a greater chilling effect.

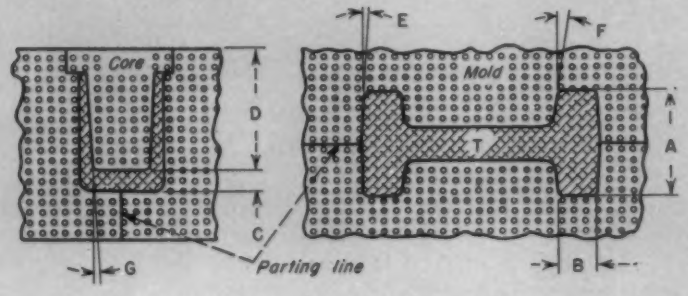
Another distinguishing characteristic of plaster molding is the setting time required for the plaster to harden

Table I—Suggested Dimensional Tolerances for Plaster Process Castings

(A) Across Parting Line: ±0.010 in. for one inch or less; above one inch add 0.001 in. to tolerance per inch of length.
(B) Between Points Produced by One Part of the Mold: ±0.005 in. for one inch or less; above one inch, add 0.001 in. to tolerance per inch of length.
(C) Between Points Produced by a Core and the Mold: ±0.010 in. for one inch or less; above one inch, add 0.001 in. to tolerance per inch of length.
(D) Maximum Length of Core Supported at One End: Diameter of Core x 5.
(E), (F) and (G) Draft: Zero draft permissible in many cases; 2 deg is desirable.

NOTES

1. Minimum diameter of separate cores — 1/4 in.
2. Minimum thickness "T" for distance of
   (a) 3 in. or less—$\frac{1}{16}$ in.
   (b) 3 to 6 in.—$\frac{3}{32}$ in.
   (c) Over 6 in.—$\frac{1}{8}$ in.
3. When plaster is used in a particular area of a casting to gain a dimensional advantage, this area of the casting should be used as reference for matching other portions.
4. Minimum Radius of Fillet—Sharp corners can be cast when desired.
5. Nominal Surface Finish—125 microinches RMS or better.



from a liquid slurry. Because of this setting period, patterns and core boxes are tied up while the material hardens. Duplicate pattern equipment is thus needed if high rates of production are desired. This problem was solved through the use of plastic and rubber materials that can be molded inexpensively to duplicate the shapes. Requiring no machining, these plastic and rubber patterns draw freely, so that when the plaster expands slightly upon setting, there is no binding.

When properly designed, these patterns bring to the fore still another benefit of the plaster process: excellent reproduceability of dimensions from one casting to another. Such is the case on first sample castings except where tolerances are extremely close and some adjustment in pattern dimensions may be necessary. The principal reason for adjustment is that a uniform pattern makers' shrinkage allowance can not be applied in the construction of patterns and models.

When faced with close tolerances, technicians have found that castings shrink differently along different axes, or in the presence of ribs, flanges and restraining members. These differences are often masked in other molding processes where extremely close tolerances are not usually expected and where generous amounts of finish stock are customary. When working to very close tolerances with the plaster process (closer than ±0.010 in.), it is sometimes necessary to estimate the shrinkage allowance as closely as experience permits, but with the expectation that it may be necessary to modify the pattern slightly on the basis of the first sample casting.

Design Considerations

In evaluating the design possibilities of the Alcoa plaster process, several new concepts can be considered. First, aluminum castings made in plaster have better dimensional tolerances and surface smoothness than sand or permanent mold castings. Tolerances and smoothness obtainable in plaster molds approach those offered by the die casting process and tooling costs are substantially lower.

Many of the general considerations that plaster offers the designer are based on the greater insulating value, as compared to more conventional mold materials. This insulation makes possible the casting of thinner sections, as well as the casting of thick and thin sections adjacent to each other in the same casting.

The insulating effect of plaster in comparison with sand and iron is also important because it makes possible a more complete application of the principles of directional solidification in castings. And the use of composite molds to secure proper solidification sequence results in excellent soundness and mechanical properties in castings.

Another application of the composite mold method is the use of plaster sections as components in sand or permanent molds to eliminate machining in cored holes or other sections requiring close tolerances or smooth surfaces. However, when machining must be performed, the area cast against the plaster can be used as a reference for machining the other parts of the casting. Accurate coring of internal passages, inaccessible for machining, can thus be achieved by use of plaster cores. In general, though fine machining tolerances cannot be fully met by plaster molds, they can and do provide the accuracy usually required.

Dimensional Tolerances

There are a number of general rules that can be adopted in defining the dimensional tolerances for plaster process castings. These are "general" since quite often much closer tolerances are possible depending on the over-all design of the casting. For example, the foundry supplying a particular casting can define the related tolerances and surface finish more accurately than can some other foundry. Achieving the best tolerances with plaster depends on whether production factors, such as time available, equipment used and number of pieces required, permit special procedures to be adopted.

Dimensional tolerances for aluminum and magnesium parts cast in plaster molds are demonstrated in Table I by two simple casting cross sections. Because of the insulating characteristics of the plaster, walls as thin as $\frac{1}{16}$ in. can be cast. This insulating characteristic may be a disadvantage, however, when pouring a large casting with heavy sections in an all-plaster mold. In these heavy sections, the rate of solidification may be reduced to such an extent that the soundness and mechanical properties of the final product are adversely affected.

Since a plaster mold can be removed relatively easily from a pattern, draft angles ("E", "F" and "G" in Table I) can be zero in many cases. A draft angle of two degrees is desirable, however, and may even help to lower the cost of producing the part.

When considering the use of a plaster mold, designers need not be especially concerned about fillet radii; sharp corners can be cast if desired, but care should be exercised so that stress raisers are not developed.

Mechanical Properties

Aluminum and magnesium castings designed for the plaster process will develop mechanical properties similar to those found in sand castings. Optimum physical properties are achieved by the correct use of all-plaster molds, and in some cases, by composite molds.

Specifications for all types of aluminum and magnesium alloy castings usually require that the average tensile strength for test specimens cut from castings should be not less than 75 per cent of the minimum requirements for separately cast test bars. Under these same specifications, the average elongation of test specimens cut from castings is required to be not less than 25 per cent of minimum values for separately cast bars. There are, in addition, some special specifications that allow the designer to specify higher minimum mechanical properties for test specimens cut from certain designated areas of the castings.

With reference to these special specifications for sand and permanent mold castings, Alcoa has amassed a considerable background of mechanical property data for a wide range of part sizes and shapes. With the advent of plaster castings, a new program was initiated to collect similar data from castings made in all-plaster molds and in composite molds. Results of this program have indicated that, when the section thickness is less than $\frac{1}{2}$ in., the mechanical properties of specimens cut from castings made entirely in plaster molds are approximately equal to the mechanical properties of sand castings of the same design and section thickness. For castings having a section thickness of $\frac{1}{2}$ to 1 in., the mechanical properties are somewhat lower.

An engineering advantage of the plaster process, however, lies in the fact that castings of heavier section thickness lend themselves readily to production in composite molds. Surfaces that require smoothness and close dimensional tolerances can be formed in plaster mold elements and other sections in sand or cast iron mold elements. By the proper application of principles of directional solidification, these composite molds can produce mechanical properties in castings at least equal, and in many cases superior, to those that could be obtained by the use of a single mold material, whether sand or cast iron.

It is important that the designer recognize this factor when designing castings to be produced by the plaster process; and it is equally important that foundry technicians clearly understand which areas in the casting are critical. By proper casting design and selection of the proper foundry method, it is usually possible to produce a casting having high dimensional accuracy and mechanical properties equal to, or better than, those that can be produced by the sand casting process alone.

Current Applications

The plaster process has been used with considerable success in the casting of bladed aluminum parts. The bladed parts shown in Fig. 2 demonstrate the fact that plaster allows the casting of thick and thin sections adjacent to each other. The thin blade-sections cast adjacent to the heavy support-sections are formed by plaster cores that give excellent surface smoothness and permit close tolerances, usually about ± 0.005 in. Blades on some of the castings shown taper to less than 0.040 in. on trailing edges. These thin sections are sometimes adjacent to hub areas of one-inch thickness. Bladed parts of the type shown have been cast with diameters as large as 72 inches.

The high degree of intricacy obtainable with the plaster process is demonstrated by the double-bladed casting in Fig. 3. Blade thickness varies from 0.040 to 0.100 in., with the distance between each pair of twin blades being

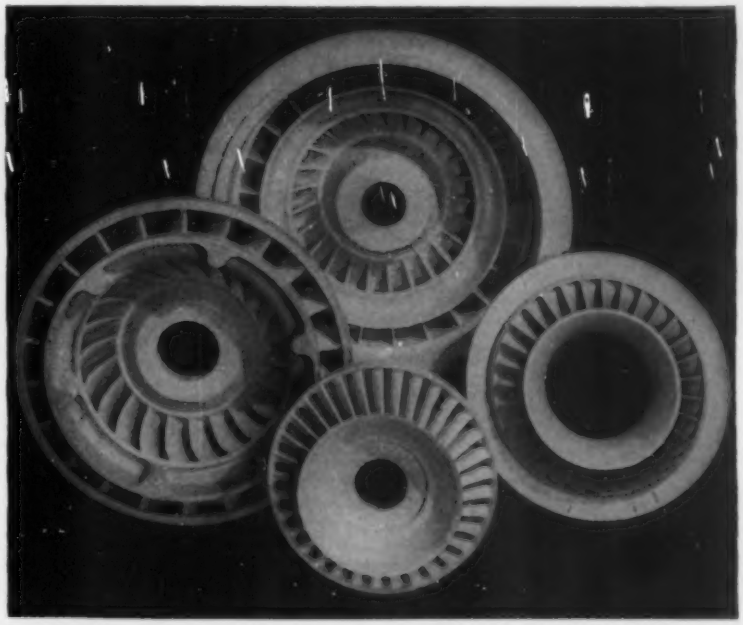


Fig. 2—Permeable plaster cores were used to cast the intricate bladed surfaces. Notable features are adjacent thick and thin sections, and close-tolerance tapered blades.

approximately 0.045 in. This type of casting formerly had to be produced by assembling the blades in the housing and then brazing.

Other samples of plaster castings are shown in Fig. 4. Made of SAE 323-T6 alloy, the wide-rimmed part (A) at lower center weighs 9 lb, has a diameter of 12.75 in., and is 10.5 in. high. The section thickness varies between 0.105 and 0.250 in. The outside was formed in an iron mold, the center hub in dry sand, and the vanes in permeable plaster. The yield strength of this casting as determined from test bars machined from the casting averaged 25,330 psi or118 per cent of the minimum for separately cast permanent mold test bars. The average tensile strengths of test bars machined from several locations of this casting are listed in Fig. 4.

The impeller casting, shown at the left (B) in Fig. 4, was cast from SAE 322 alloy using green sand drag, dry sand cope and with the vanes formed by plaster cores. This 15-in. diameter casting, when given the —T61 treatment, displayed an average tensile strength of 28,400 psi on test bars taken from the 3-in. thick hub section, or 78.8 per cent of the minimum value for separately cast, sand molded bars.

Castable Alloys

All the aluminum and magnesium alloys that can be successfully cast in sand molds are suitable for casting in all-plaster or in combination molds. Because of their casting characteristics, however, certain alloy groups are more suitable for the process than others. The aluminum-silicon alloys, SAE 35, in particular, are best for fine detail and for thin sections. The aluminum-silicon-magnesium alloys, such as SAE 323, and the aluminum-silicon-copper alloys, such as SAE 326 and 322, also possess excellent characteristics for casting in combination molds containing plaster or all-plaster molds.

Special reaction-inhibiting agents must be added to the plaster mold material to permit casting of magnesium.

Finishing

Castings produced in plaster molds can be finished by all the chemical dip, electrochemical and electroplating methods that are applicable to sand castings, but with less prior mechanical finishing. As in sand castings, the color, the thickness and the physical characteristics of the coatings will be dependent on the alloy of which the casting is made.

Because of the characteristically smooth surface of plaster process castings, only a minimum of hand or mechanical finishing is required. The need for grinding and buffing, in most instances, is avoided through the use of the plaster. Castings can be prepared by either stone or ball burnishing, or both, to remove flashes and round sharp corners. Finishes obtained by these methods are inexpensive, and may range in color from a matte gray to a bright shiny luster depending on the treatment and the burnishing compounds used. These finishes are used on small high-production castings.

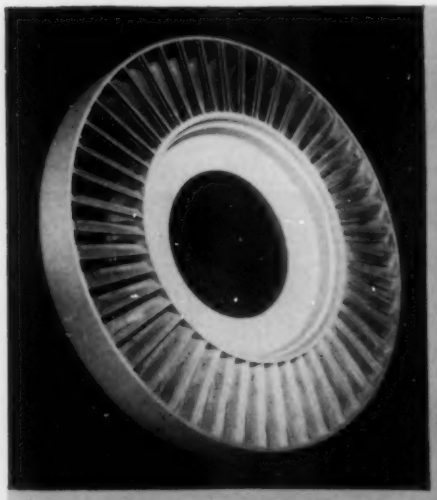


Fig. 3—Double-bladed casting demonstrates extreme intricacy possible with plaster casting process. Thickness of blades varies from 0.040 to 0.100 in. with the distance between each pair of twin blades being about 0.045 inch.

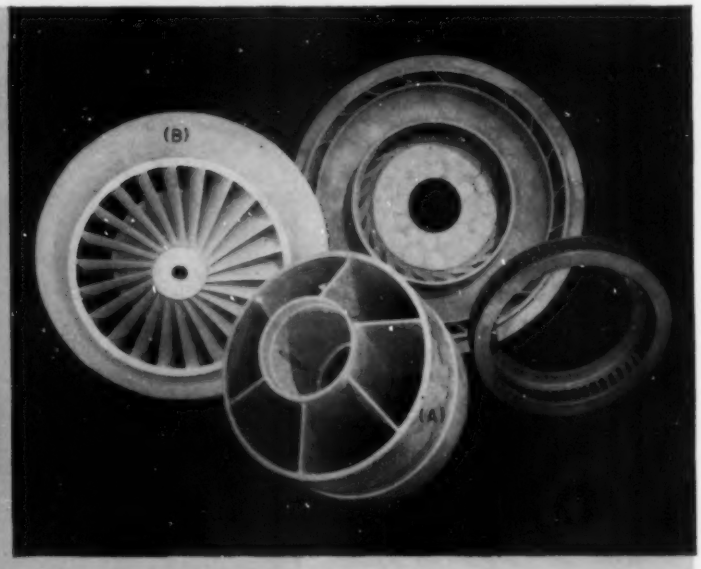


Fig. 4—Composite-mold aluminum castings: (A)—iron, dry sand and plaster, (B)—green sand, dry sand and plaster. Values for average tensile strength in selected areas of casting (A) are shown in tabulation.

Tensile Strength in Different Parts of Casting (A)

Specimen Location	Mold Surface Type	Average Ten. Str, Psi	Per Cent of Minimum for Separately Cast Permanent Mold Test Bars
Vanes.....	Plaster	33,600	105.0
Outer Ring....	Plaster-Iron	33,550	90.6
Inner Ring....	Plaster-Sand	32,160	100.0

MECHANICAL COMPONENTS FOR AUTOMATIC CONTROL

In addition to the electrical components covered in "Rotating Components for Automatic Control" (*Product Engineering*, November 1953), there is also a group of rotating mechanical components that is often required in automatic control system applications. This group includes gearing, clutches, and mechanical hardware.

Presented here are the factors involved in the design and application of gear trains, the operating characteristics and application techniques of various types of clutches and a discussion of typical commercially-available mechanical elements.

SIDNEY A. DAVIS
Chief Development Engineer
Components Division
Servomechanisms, Inc.

Copyright 1954 by McGraw-Hill Publishing Co., Inc., 330 West 42nd St., New York 36, N. Y.

MECHANICAL COMPONENTS FOR AUTOMATIC CONTROL

Gearing for Closed Loop Systems

Automatic Control Clutches

Mechanical Apparatus for Servo Construction

Table I—Functions of Gearing in Automatic Control Systems

1. Positive mechanical linkage between shafts.
2. Matching of driving member to load for most efficient power transfer, maximum load acceleration, or other special system requirements.
3. As a scale changing device.
4. For setting up multi-digit visual dial information.
5. For reversing direction of rotation.
6. For performing addition and subtraction, especially important in feedback control.
7. As a means of gain adjustment of closed loop systems.

Gearing for Closed Loop Systems

AUTOMATIC CONTROL SYSTEM applications require high quality gears to satisfactorily perform the various functions listed in Table I. To achieve these functions the following factors are important in the selection and specification of control system gearing:

1. Gear ratio — for optimum matching of motor and load.

2. Gear materials — chosen not only for adequate life under a specific duty cycle, but also for minimum incremental system inertia. This latter factor is closely related to the closed loop stability (freedom from hunting) of high performance systems. Environmental conditions that can induce corrosion and accelerate wear are also important material selection factors.

3. Precision — related directly to the accuracy of the gear drive computer components. Gear accuracy is often the limiting factor in the accuracy of a control function.

4. Backlash — resulting from the imperfect location of centers, tooth wear and inaccurate gear contours — can be the source of closed loop instability.

5. Power handling ability and the rigidity of the tooth and shaft under

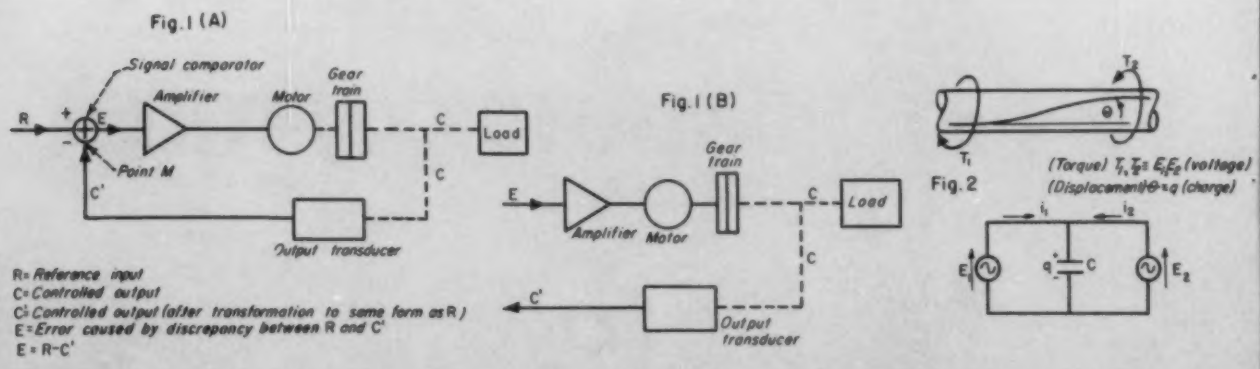


Fig. 1 — Characteristic schematic of closed loop system, (A). The arrangement obtained by opening the loop at point *M*, as shown in (B) is useful in establishing stability criteria.

Fig. 2

Fig. 2 — Equivalent circuit of a shaft under torsion showing analogous quantities.

rapid reversal and impact – influence life and stability.

6. Special features—such as the use of a slip clutch to avoid peak loads, the use of a spring-loaded anti-backlash gear, the choice of enclosure and bearing seals to minimize the possibility of foreign particles becoming lodged in the tight meshes, the choice of lubricant and the type of shaft bearing – are additional design factors.

Effect of Gearing on System Performance

A system of ideal gearing would give the designer a transforming device that uniformly converts between torque and speed with no residual irregularities to disturb the analysis. Actually all gearing contributes certain irregularities that must be considered when designing a system.

The effect of these residual irregularities can be seen from an examination of the basic cause of instability in closed loop systems. Fig. 1 (A) shows the characteristic schematic for closed loop systems. The condition for instability can be established by opening the loop at point M and comparing the signal C' at M with the error signal E. Assuming that E oscillates sinusoidally, then the response will also oscillate sinusoidally. The relative response amplitude and phase shift of C' with respect to E will be a function of frequency. If the response-to-error ratio, C'/E, is one or greater at a frequency that will give a 180 deg phase shift, then there is sufficient response energy to cause oscillation or instability when the loop is closed. The phase shift of 180 deg means that the correction or response C' adds to the error rather than subtracting from it. Thus, if the amplification around the loop is sufficiently high, and the phase shift gives effective positive feedback, oscillation will occur.

The important factor is the phase shift that results from either the residual or inherent inertial and spring properties of the members. These can be taken as respectively analogous to the inductive and capacitive elements of an electrical circuit. Because of their capacity to delay the flow of energy by momentarily absorbing it, they prevent the immediate application of the correction and thereby cause phase shifts. Components of this nature are known as energy storage elements and the number and capacity of these elements should be minimized to achieve system stability.

The stability characteristics of a set of gears in a feedback system can be directly measured by the residual energy storage elements that the gears add to the system. These can take the form of inertias, dead space and resilience.

In Fig. 2 is shown the electrical analog of a shaft having a certain amount of resilience. In effect the resilience is similar to shunt (stray) capacitance in electrical systems. For a perfectly rigid shaft θ equals 0. Strain beyond the elastic limit, such as can occur under shock loads, tends to reduce stiffness and introduces nonlinearity. The electrical equivalent would be a hypothetical nonlinear dielectric condenser. In systems having high inertias and insufficiently rigid shafting, severe oscillation can be induced by this energy storage.

An elementary system consisting of two coupled rigid members having dead space (backlash) in the coupling is shown in Fig. 3. It is assumed that the input shaft is oscillating sinusoidally. Since backlash is a type of nonlinear compliance, the electrical equivalent can again be represented by a shunt capacitor. In establishing system stability, it is necessary to consider the above resilient shaft, or the coupling with backlash, as cascaded elements in the loop contributing phase shift and therefore instability. Since nonlinearity is involved, the stability criteria must be made more general.

Applying a sinusoidal torque (or voltage) to the coupling, the output torque (or voltage) will take the distorted form shown in Fig. 3 (C). A good approximation of the transfer characteristic of the coupling can be obtained by using only the fundamental Fourier component of the output, neglecting the harmonics. The relative phase shift and attenuation of the fundamental output with respect to the input or complex gain are also illustrated. In this specific example, the value of this complex gain is independent of frequency, so that the coupling can be directly introduced into the servo loop as a complex quantity. However, the complex gain is a function of error amplitude with maximum nonlinearity introduced at small input amplitudes, since backlash is constant and does not vary with error. Thus the system must be checked for stability for all possible values of complex gain. Oscillation at any realizable value of this gain means instability. This broader stability criterion emphasizes the increased difficulty in stabilizing systems in the presence of nonlinearity.

The above examples show that the nonlinearities that are present in mechanical elements contribute to the difficulty of securing satisfactory control system performance. Fig. 4 extends this method of analysis to a complete gear train, demonstrating the numerous energy storage elements that are encountered. Additional components of

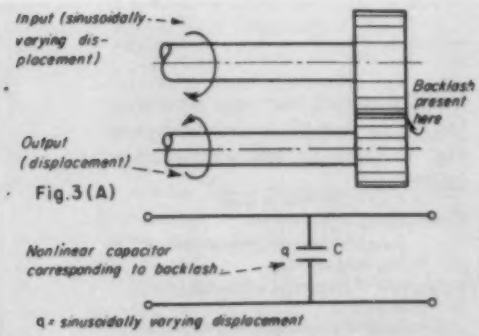
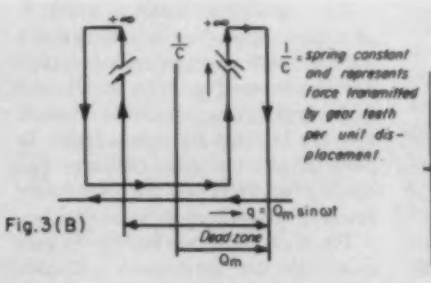
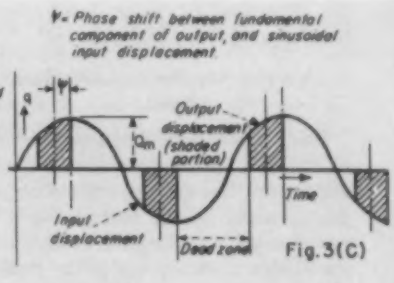


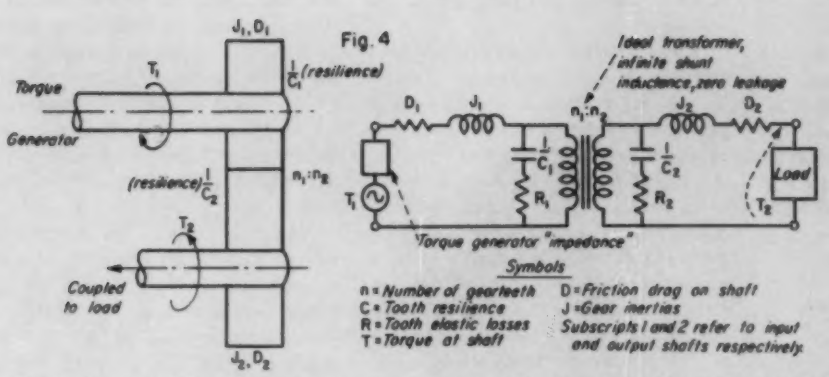
Fig. 3(A) – Gear coupled shafts in the presence of backlash with equivalent electrical circuit. The input shaft is subjected to a sinusoidally varying displacement.



(B) – Plot of the reciprocal capacitance versus charge for a nonlinear capacitor with the charge varying sinusoidally. In a gear system with backlash this diagram represents a plot of displacement versus force transmitted by the teeth.



(C) – Displacement or charge as a function of time for a sinusoidal input. The phase shift, ψ, and distorted output wave form (represented by the shaded portion of curve) are caused by the dead space or backlash.



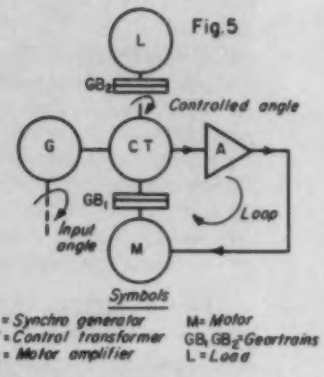


Fig. 4—Exact equivalent circuit for a gear train. The numerous energy storage elements can contribute to the tendency toward oscillation.

Fig. 5—The effect of gearing *GB*1 is to include additional storage elements within the closed loop. By substituting the equivalent circuit of Fig. 4 for *GB*1, the loop stability can be determined. *GB*2, which is outside the loop, does not contribute to instability, although backlash here can result in inaccurate positioning of the load.

lower order importance can complicate the picture further where high quality performance specifications require a more detailed study. An example of this is the effect of end play and side play in the bearing mounts of the gearing or motor. In high performance systems these factors can force the use of preloaded bearings even though the harmful effects of increased friction and reduced accuracy are introduced.

In Fig. 5 is shown a schematic of a complete servomechanism which indicates the nature of the instability caused by residual mechanical energy storage elements. In well designed systems, the resiliences can be kept small, minimizing undesired resonances. This is particularly important in systems where a wide servo band width is required since even slight resilience can cause trouble. The principal difficulties encountered in wide band systems result from unexpected resonances occurring at some frequency within the desired band width. This is analagous to the deleterious effects of stray capacitance in wide-band amplifiers.

Choosing the Motor-Load Gear Ratio

For a given control system there is an optimum gear ratio that will minimize errors. The exact determination of this optimum for the general case is a complex task and requires a statistical knowledge of the nature of the input. In addition, a clear mathematical statement of what constitutes minimum error is required. System nonlinearities, such as may be introduced by a fan load (where power increases as the cube of the speed) or by the curved speed-torque characteristic of a real two-phase servo motor, add complications. Where maximum overall precision is required, as in problems of fire control requiring maximum hit density, the object of system optimization is to control the statistical error for probable target paths so as to achieve the maximum number of target hits. It is usually a difficult problem to reduce a set of physical conditions to a satisfactory statistical statement of what constitutes optimization.

For most control problems, simplified criteria can be set up to facilitate an approximation of the optimum gear ratio. The gear ratio figure can be refined through a series of successive approximations, including more detail in the final stages of calculation. In practice an accuracy within plus or minus 20 percent is usually satisfactory. Table II lists some of the frequently encountered selection situations.

The equivalent circuit method of gear train analysis can be used to determine the optimum gear ratio for specified conditions. Fig. 6 (A), (B), and (C) show three simplified circuits, that can be used for this purpose. In these circuits the tooth resilience (including backlash) and the tooth elastic losses are considered to be negligible.

Fig. 6 (A) involves finding the gear ratio for the maximum dissipative (friction) load velocity under steady state conditions.

Since equivalent circuit calculations are made using electrical quantities, electrical symbols have been substituted for the mechanical symbols shown in Fig. 4. These symbols correspond as follows

$E \equiv T$ = torque at shaft
$L \equiv J$ = gear inertia
$R \equiv D$ = friction drag on shaft
$I \equiv$ load velocity
$a \equiv n_1/n_2$ = reciprocal gear ratio (less than one)
Z = electrical impedance of L and R in in series.

From the circuit configuration comes

Table II—Common Situations in Gear Ratio Selection

1. When the reference signal varies at a relatively constant speed, the gear ratio should permit following at this speed.
2. When the reference signal experiences sudden increments (high acceleration) the gear ratio should be selected to achieve maximum torque to inertia ratio at the output.
3. Where static accuracy or slow smooth following is a principal consideration, the gear ratio should amplify motor torque so that the output torque is capable of maintaining the error within allowable limits. This gear ratio is usually inefficient in terms of power transfer to the load.
4. When there are special requirements such as the ability to simultaneously maintain a specified velocity and acceleration, or the need for rapid reversal, or the requirement of minimum time to come up to speed or a maximum allowable braking time.
5. When a specified friction load is to be carried at a given speed. (Either a constant friction or a linear speed-varying drag).

Fig. 6 (A)

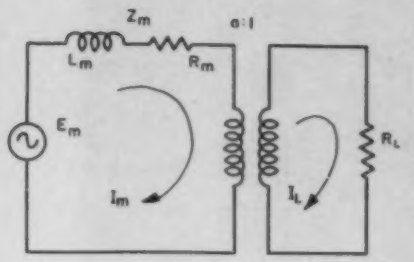


Fig. 6 (B)

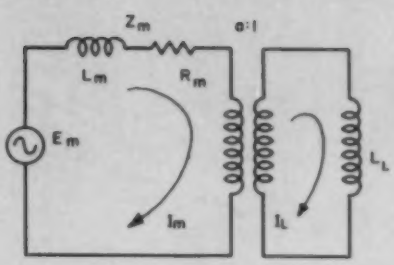


Fig. 6 (C)

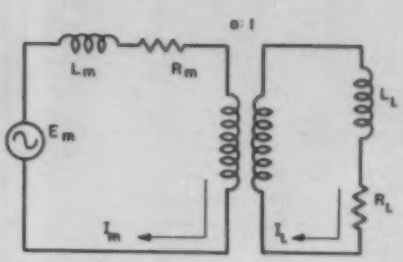


Fig. 6 — Simplified equivalent circuits used to solve three practical problems in the selection of proper gear ratio. (A) is for condition of maximum dissipative load velocity under steady conditions, (B) is for condition of maximum inertial load acceleration, and (C) is for a condition of minimum required motor torque to attain a specified load velocity and load acceleration.

the following relationships:

$$I_m = \frac{E_m}{Z_m + a^2 R_L} \quad (1)$$

and $$I_L = \frac{aE_m}{Z_m + a^2 R_L} \quad (2)$$

Under steady state conditions the drop across the inductance L_m is zero (or input gear inertia does not affect system performance under a condition of constant angular velocity). Thus the load velocity can be expressed by

$$I_L = \frac{aE_m}{R_m + a^2 R_L} \quad (3)$$

To determine optimum parameters for a given condition let the change in I_L with respect to a be zero.

$$\frac{dI_L}{da} = \frac{E_m(R_m + a^2 R_L) - 2a^2 E_m R_L}{(R_m + a^2 R_L)^2} = 0 \quad (4)$$

and $$R_m + a^2 R_L - 2a^2 R_L = 0$$

$$R_m = a^2 R_L \quad (5)$$

$$a = \sqrt{\frac{R_m}{R_L}} \quad (6)$$

This means that the optimum gear ratio for this condition is equal to the square root of the ratio of motor frictional drag to load frictional drag. This is analogous to the condition of matching electrical impedances.

Fig. 6 (B) shows the gear ratio for maximum load acceleration for an inertia load. Assume that the velocity is initially zero (I_m equals 0) and that a torque E_m is suddenly applied.

Under this condition the motor torque can be expressed approximately by the following equation

$$E_m \cong (I_m + a^2 L_L)\frac{dI_m}{dt} \quad (7)$$

and load acceleration, A_L, is:

$$A_L = \frac{I_L}{dt} = a\frac{I_m}{dt} \quad (8)$$

Combining Eq(7) and Eq(8), the load acceleration is equal to

$$A_L = \frac{aE_m}{L_m + a^2 L_L} \quad (9)$$

which is similar in form to Eq (3) of the previous problem. To determine the system parameters for the condition of maximum inertial load acceleration, derive the expression for the change in A_L with respect to a and equate to zero.

$$\frac{dA_L}{da} = \frac{E_m(L_m + a^2 L_L) - 2a^2 E_m L_L}{(L_m + a^2 L_L)^2} = 0 \quad (10)$$

and $$L_m + a^2 L_L - 2a^2 L_L = 0$$

$$a = \sqrt{\frac{L_m}{L_L}} \quad (11)$$

Thus the optimum gear ratio for this condition is equal to the square root of the ratio of motor inertia to load inertia.

Fig. 6 (C) gives the gear ratio that will require minimum motor torque to achieve a specified maximum load velocity and maximum load acceleration with the load having both friction and inertia. The given quantities are the motor and load frictional drag, R_m and R_L, the motor and load inertia, L_m and L_L, and the specified load velocity, I_L, and specified load acceleration, dI_L/dt. To find the optimum gear ratio express the motor torque, E_m, as a function of the circuit constants.

$$E_m = R_m I_m + L_m\frac{dI_m}{dt} + aR_L I_L + aL_L\frac{dI_L}{dt} \quad (12)$$

substitute $I_m = \frac{1}{a} I_L$ and $\frac{dI_m}{dt} = \frac{1}{a}\frac{dI_L}{dt}$

and differentiate Eq(12) with respect to a

$$\frac{dE_m}{da} = -\frac{R_m I_L}{a^2} - \frac{L_m}{a^2}\frac{dI_L}{dt} + R_L I_L + I_L\frac{dI_L}{dt}$$

Equating this to zero and solving for the gear ratio gives

$$a = \sqrt{\frac{R_m I_L + L_m\frac{dI_L}{dt}}{R_L I_L + L_L\frac{dI_L}{dt}}} \quad (13)$$

This is the optimum gear ratio for the given conditions of load.

Once the correct overall gear ratio has been selected, such design factors as the number of stages, stage ratios and manufacturing tolerances must be considered.

Gear Design Factors

Low gear inertia is a principal design factor, and together with backlash constitute 95 percent of the problems encountered in the design of gearing for control system applications. The important points that affect gear train inertia are:

Choice of materials — Gear materials should have minimum density consistent with the requirements of satisfactory durability under specified duty cycles. Aluminum gears are being widely used in instrument servos.

Width of face — This depends on the required load torques and the strength of the gear material. The minimum width in low power instrument servos is established by the need for rigidity rather than the load demands.

Gear blank design — A minimum of material should be used with the unstressed sections designed out.

Number of stages and choice of stage ratios — The effective system inertia for a given overall gear ratio between the driving element and the load can be minimized by the proper choice of ratio per stage of gearing. (Overall

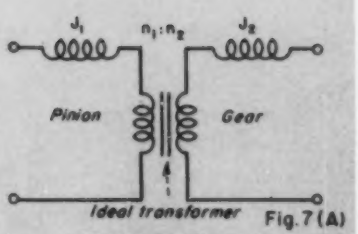


Fig. 7 (A)

J = gear inertia
n = number of gear teeth
ρ = density of gear material
W = gear face width

Subscripts 1 and 2 refer to pinion and driven gear respectively

To determine the inertia of the driven gear when the pinion inertia is known, the following expression applies

$$J_2=\left(\frac{n_2}{n_1}\right)^4\left(\frac{\rho_2}{\rho_1}\right)\left(\frac{W_2}{W_1}\right)J_1$$

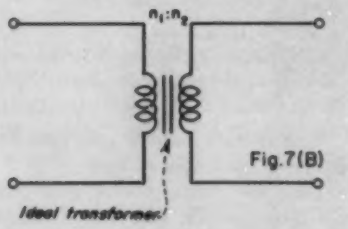


Fig. 7 (B)

Fig. 7 — Approximate equivalent circuits for simplified gear train analysis. Circuit in (A) assumes an ideal gear train but includes effects of gear inertia. In actual applications the pinion diameter is kept to a practical minimum. (B) neglects gear inertia and is useful in well designed systems where the inertia of the motor and load predominate.

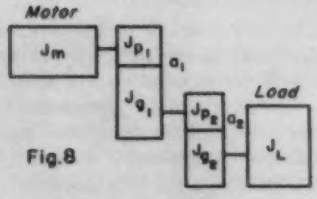


Fig. 8

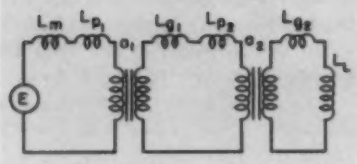


Fig. 8 — Two-stage gear train and equivalent circuit of gear train. Stages have finite inertia. Object is to determine a_1 and a_2 for minimum reflected inertia to motor shaft.

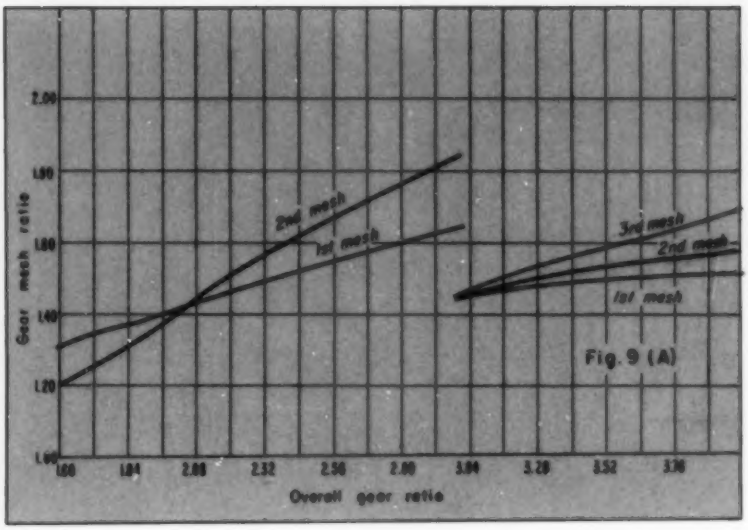


Fig. 9 (A)

gear ratio is determined as discussed above.) Usually where a high speed motor drives a low speed load, the first stage or two have relatively low ratios in a good design. The gears beyond the second stage contribute little to the overall inertia reflected to the motor shaft.

Within the limits of mechanical gear design, the equivalent circuit is useful in minimizing gear inertia by indicating the optimium stage ratios. As a necessary prerequisite to obtaining a suitable closed loop stability margin, the resiliences, backlash, mechanical strength and nonlinear friction characteristics are made negligible by proper gear design. Thus in most practical problems the equivalent circuit can be simplified in comparison with the exact version. Fig. 7 (A) shows an approximate equivalent circuit that is suitable for the dynamic analysis of most closed loop systems. Where gear inertias are also negligible, the equivalent circuit further reduces to the form shown in Fig. 7 (B).

A two-stage gear train with finite inertia in the separate stages and the equivalent circuit of this gear train are illustrated in Fig. 8. The problem is to select the stage gear ratios a_1 and a_2 so that minimum inertia is reflected back to the motor shaft. In this example the overall ratio of load speed to motor speed, a, is specified at some value less than one and

$$a=a_1a_2 \tag{14}$$

To simplify the approach it is assumed that the same gear materials, and face widths are used throughout, and that the shafts, clamps and other required hardware contribute negligible inertia. None of these assumptions is essential and they are only made to facilitate the solution of the problem. The equivalent circuit approach is suitable for any general situation.

Using the equation shown in Fig. 7 (A), for a condition of equal face widths and similar materials, the ratio of gear to pinion inertia in the two stages can be represented by

$$\frac{J_{g1}}{J_{p1}}=\frac{1}{a_1^4} \tag{15}$$

and

$$\frac{J_{g2}}{J_{p2}}=\frac{1}{a_2^4} \tag{16}$$

Assume for convenience that the inertia of the two pinions is equal so that

$$J_{p1}=J_{p2}=J_p$$

Therefore,

$$J_{g1}=\frac{1}{a_1^4}J_p \tag{17}$$

and

$$J_{g2}=\frac{1}{a_2^4}J_p \tag{18}$$

To determine the reflected inertia as seen at the motor shaft, add up the inertia of each element raking into account the relative speed (gear ratio) relative to motor shaft speed. Electrical symbols from the equivalent circuit are used.

$$L_T=L_m+L_p+(L_{g1}+L_p)a_1^2+(L_{g2}+L_L)a^2 \tag{19}$$

where L_T = total inertia reflected to motor shaft.

Substituting Eqs (15) and (16) in Eq (19)

$$L_T=L_m+L_p+\left(\frac{L_p}{a_1^4}+L_p\right)a_1^2+\left(\frac{L_p}{a_2^4}+L_L\right)a^2 \tag{20}$$

Substituting Eq (14), the above

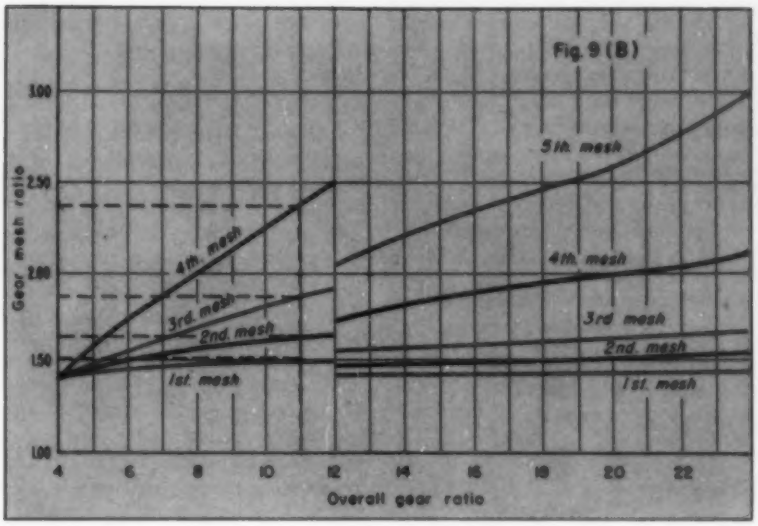


Fig. 9— Optimum number of gear stages and the individual mesh ratios for minimum reflected moment of inertia.

equation can be simplified

$$L_T = L_m + L_p + L_p\left(\frac{1}{a_1^2}+1\right)a_1^2 + \left(\frac{L_p}{d^2}a_1^4 + L_L\right)d^2 \quad (21)$$

To determine the first stage ratio, a_1, in terms of the overall gear ratio, d, differentiate the left hand term with respect to a and equate the result to zero:

$$\frac{dL_T}{da_1} = -\frac{2L_p}{a_1^3} + 2a_1L_p + 4\frac{L_p}{d^2}a_1^3 \quad (22)$$

Equating to zero and solving for a_1

$$2 = 2a_1^4 + \frac{4}{d^2}a_1^6 \quad (23)$$

The first term is numerically negligible in most systems and therefore a_1 becomes approximately

$$a_1 = \sqrt[6]{\frac{d^2}{2}} \quad (24)$$

This means that for minimum reflected inertia in a two-stage gear train, the first stage ratio should bear this relation to the overall gear ratio.

Using the first stage gear ratio calculate the ratio of gear train inertia to motor pinion inertia.

$$L_T' = L_p + L_p a_1^2\left(\frac{1}{a_1^2}+1\right) + \frac{L_p a_1^4}{d^2} \quad (25)$$

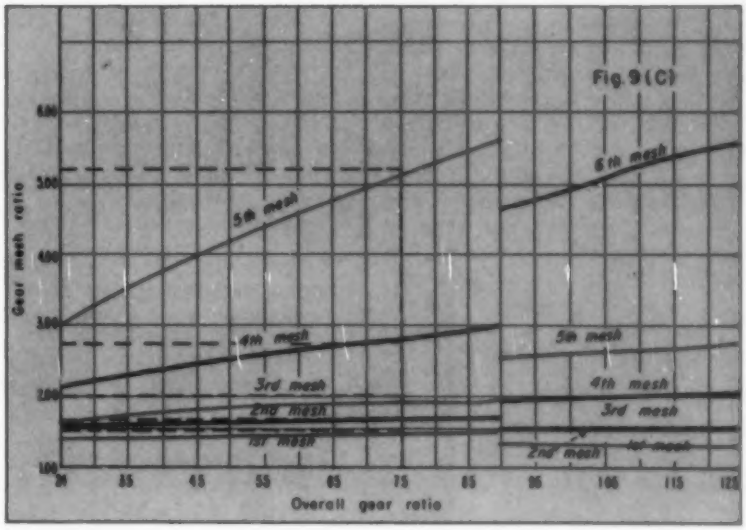
where L_T' = gear train inertia as seen from motor shaft.

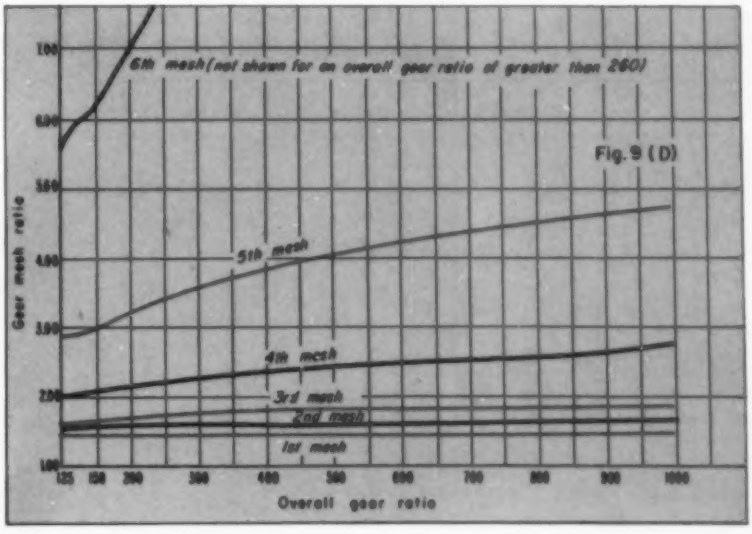
$$\frac{L_T'}{L_p} = 1 + \frac{1}{d^2}(1/2)^{2/3}d^{4/3} + (1/2)^{1/3}d^{2/3} + (1/2)^{-1/3}d^{-2/3} \quad (26)$$

Simplify this expression to

$$\frac{L_T'}{L_p} = 1 + \frac{3}{(2d)^{2/3}} + \sqrt[3]{\frac{d^2}{2}} \quad (27)$$

This represents the inertia for a two-stage gear train. For comparison with a single-stage gear train having the same overall ratio, d, the ratio of total inertia





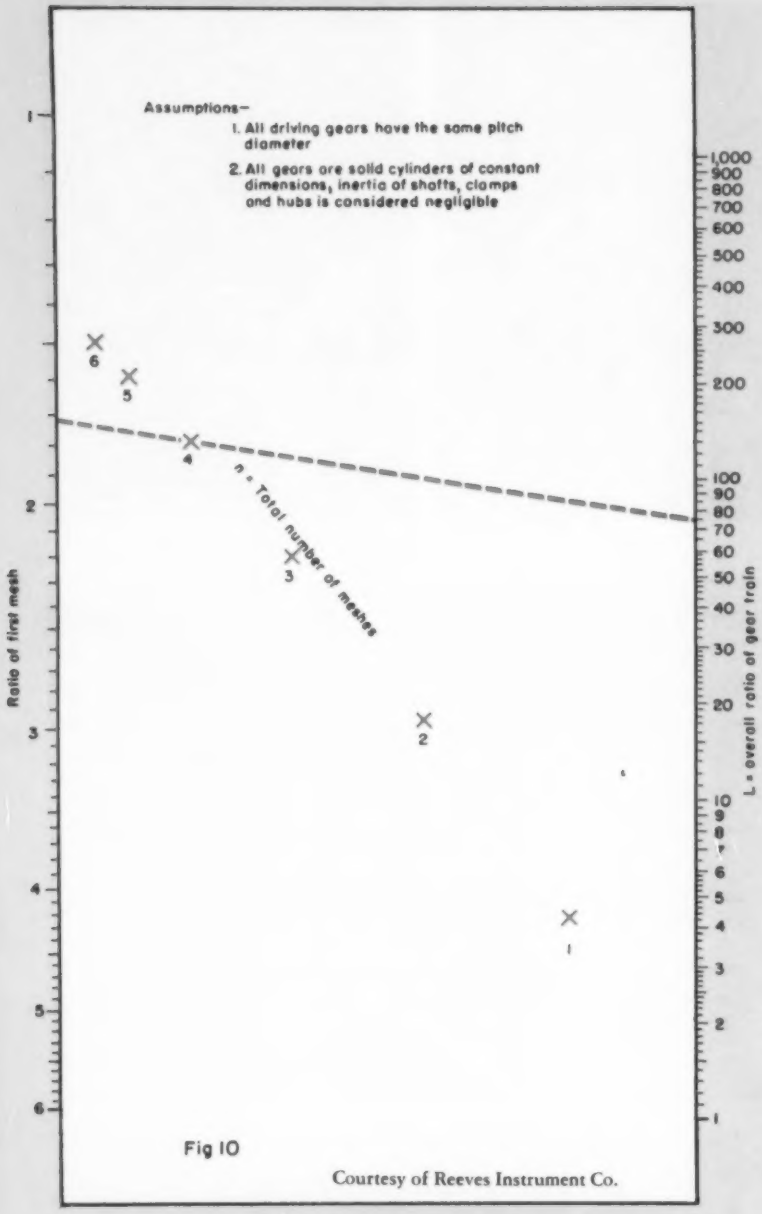

Assumptions–
1. All driving gears have the same pitch diameter
2. All gears are solid cylinders of constant dimensions, inertia of shafts, clamps and hubs is considered negligible
Ratio of first mesh
n = Total number of meshes
L = overall ratio of gear train
Fig 10
Courtesy of Reeves Instrument Co.

Fig. 10 — Nomogram for approximating the optimum ratio for each gear mesh when the number of gear stages and overall gear ratio are specified.

to motor pinion inertia for a single stage can be expressed by

$$\frac{L_T'}{L_p} = \frac{1}{a^2} + 1 \qquad (28)$$

Substitute a known total ratio, say a equals 1/27, in Eqs (28) and (27). For a single-stage train

$$\frac{L_T'}{L_p} = 27^2 + 1 \cong 27^2 \qquad (29)$$

and for an ideally scaled two-stage train

$$\frac{L_T'}{L_p} \quad \frac{27}{2^{2/3}} + \frac{1}{2^{1/3}}\left(\frac{1}{9}\right) + 1 \qquad (30)$$

The second and third terms of Eq (30) are negligible in a first approximation so that for this particular overall ratio the ratio of total gearing inertia with one stage to total inertia with two stages is

$$27(2)^{2/3}$$

Thus the use of multiple staged gearing results in a lower gearing inertia. However, there are other factors to be considered such as required manufacturing tolerances, space limitations and cost.

In Figs. 9 (A) to (D) are shown four sets of curves that can be used to determine the number of gear meshes and the ratios of the individual meshes for minimum total reflected gear train inertia to the driving shaft. These curves can be used for overall gear ratios ranging from 1.60 to 1,000. For example, if the overall gear ratio is 11, refer to Fig. 9(B). The optimum number of gear stages is four and the approximate mesh ratios for minimum inertia are:

1st mesh — 1.51
2nd mesh — 1.63
3rd mesh — 1.86
4th mesh — 2.36

or if the overall ratio is 75, Fig. 9 (C), then five stages will give the minimum reflected inertia and the approximate

Fig. 11 — (right) Circuit used for the simulation of gear backlash in analog computers.

Fig. 12 (far right) — Backlash effects in a simple second order servo. (A) shows the servo block diagram including a gear reduction stage with an overall ratio of θ_c/θ_m. The hysteresis loop of (B) shows the input-output angular relations of the gear train including the effects of total backlash 2δ. (C) shows a plot of the ratio of motor oscillation amplitude to backlash as a function of the system gain and motor time constant.

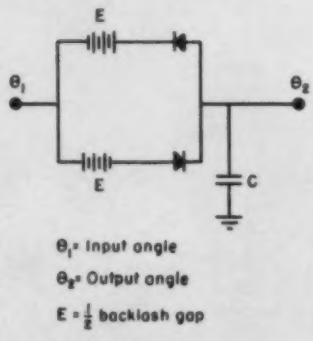


Fig. 11

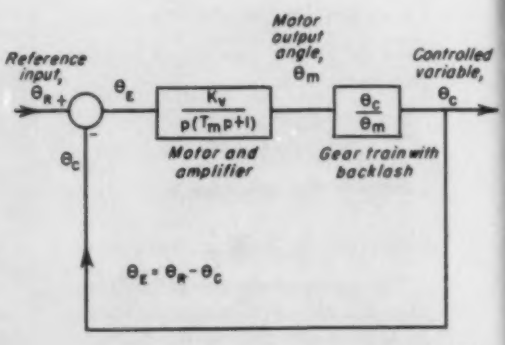


Fig. 12(A)

mesh ratios are:

1st mesh — 1.55
2nd mesh — 1.65
3rd mesh — 2.00
4th mesh — 2.77
5th mesh — 5.20

These values can be rounded out to give feasible gear ratios and to obtain the exact overall ratio.

While the curves shown in Fig. 9 are useful if the optimum number of stages are used for a required overall gear ratio, there can be a condition where for simplicity one or two fewer gear stages are specified for the same overall ratio. If this is done, the nomogram shown in Fig. 10 is useful as an auxiliary tool to determine the individual stage ratios that will give minimum reflected inertia for any given overall ratio and any given number of stages. Thus this nomogram can be used for the optimum number of stages or fewer than the optimum number of stages.

For example, as indicated above, the optimum number of stages for an overall gear ratio of 75 is five. However, if simplicity of the mechanical set up and conservation of space are important factors in design a four mesh system can be used with only a small increase in reflected inertia. Assume this is the desired condition.

Referring to the nomogram, place a straight edge through the point representing the total number of stages (4), and the overall gear ratio on the right hand scale (75:1). From the left hand scale it can be seen that the gear ratio of the first stage is 1.72 (compared to 1.55 as obtained above for five stages). Round this off to 1.75 and determine the remaining gear ratio, 75/1.75 equals about 43. Repeat this process using 43 as the overall ratio and 3 as the number of stages to determine the second stage ratio. The other stage ratios are found in a similar manner.

The convenience criterion for the use of Figs. 9 and 10 is as follows: if the optimum number of stages is used, determine the total number of stages and the individual stage ratios from Fig. 9; if any other than the optimum number of stages is used determine the individual stage ratios from Fig. 10.

Extended Use of Equivalent Circuits

The exact and approximate equivalent circuits that are given in Figs. (4) and (6) are useful where it is desired to set up an analogous electrical equivalent of a servo loop. The effects on stability, a study of stress under rapid reversal, or the impact of an inertia load against a limit stop can be evaluated. Fig. 11 shows a second circuit for the simulation of backlash in analog computer stability studies. This analogy is quite distinct from the equivalent circuits shown previously, since analog computers operate directly by integrations and differentiations performed on the dynamic equations and do not depend on a one-to-one correspondence between electrical and mechanical elements.

Gear Backlash

Backlash is the most difficult of the residual effects to control and consequently merits special atention. As a theoretical problem, backlash can be represented by a nonlinear capacitor as shown in the equivalent circuit of Fig. 3. Backlash introduces a phase shift in a servo loop that is independent of frequency but varies with amplitude. This phase shift reaches a maximum at a relatively small signal amplitude and any tendency to oscillate because of backlash will manifest itself as a small amplitude oscillation.

Coulomb friction has been found satisfactory as a damping medium for oscillations derived from backlash. This is because the fixed coulomb drag contributes a high damping coefficient when velocity and amplitude are small. However, coulomb friction cannot be applied indiscriminately because of its deleterious effect on static accuracy.

In sluggish systems having one major time constant that is effective in the frequency band width, or in systems where the normal mode of operation is steady tracking, backlash requirements can be somewhat relaxed.

In Fig. 12 (A) is shown a simple second order servo with backlash in the motor output gear train, while Fig. 12 (B) shows the hysteresis loop relating gear train angular input and output where δ is $\frac{1}{2}$ of the total backlash. The curve of Fig. 12 (C) is a plot of the ratio of motor oscillation amplitude versus the product of system gain and motor time constant. This plot shows that if the product $K_v T_m$ is greater than 3.046, oscillation will occur. Conversely, if the system gain is low enough or the motor time constant is so small that $K_v T_m$ is less than the critical value, there will be no oscillation. Thus, whether oscillation will occur or not is a function of the system constants and not of the magnitude of the backlash. The curve shows that a reduction in backlash, δ, will cause a corresponding reduction in oscillation amplitude, $\bar{\theta}_m$ since the ratio of $\bar{\theta}_m/\delta$ is fixed depending on the value of the product $K_v T_m$.

The presence of coulomb friction limits the usefulness of a curve such as this. Regardless of the critical value at which oscillation theoretically starts,

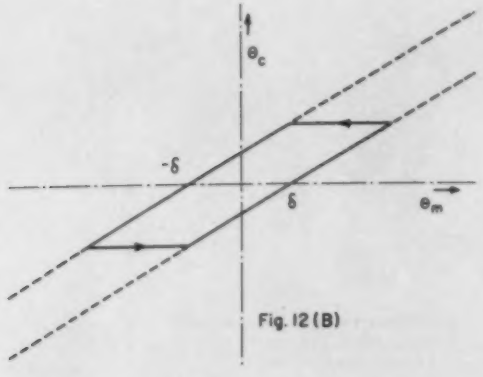
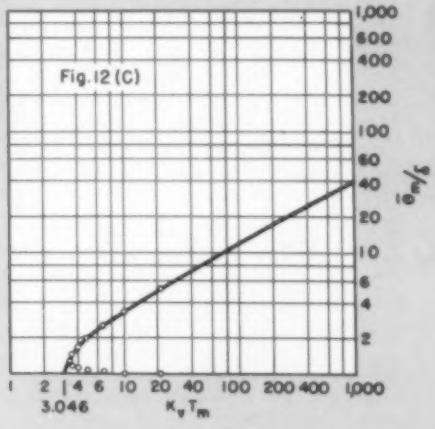


Fig. 12 (B)

T_m = Motor time constant
K_v = Gain
δ = $\frac{1}{2}$ total backlash motion
$\bar{\theta}_m$ = Maximum amplitude of motor oscillation



when the amplitude of the backlash oscillation falls below a certain limit (depending on the amount of friction) the oscillation will cease.

Backlash is especially severe in high-gain wide-band servo systems, where the sensitivity is sufficient to detect the slightest irregularities in the transmission characteristics of the gears. Backlash chatter and noise generated by high frequency tooth irregularities cause jerky and uneven following by the output member. For optimum performance, many common groupings of components are manufactured as basic sub-assemblies, with direct shaft coupling in lieu of gearing wherever possible. For example, an induction motor generator that is used as a combined damping and drive element in instrument servo-mechanisms. Even a minute dead space between a motor and its tachometer damping element effectively disconnects the damping temporarily, causing instability.

Where required speed ratios or mechanical considerations make direct coupling impossible, spring-loaded gears can be used to prevent backlash, Fig. 13. These are used in precise coupling applications; however, they are expensive and contribute excessive friction and wear. Tests on spring-loaded instrument gears indicate that the wear can be many times greater than might be expected from direct consideration of the effective load, including the additional spring force. This is caused by bounce under transient conditions that results in repeated impact of the spring-constrained inertial masses.

The springs used in anti-backlash gearing must be of a high uniform quality if constant specified tooth loading is to be maintained in mass production. Gears are available with either tension or compression springs, both types being equally satisfactory. Some designs totally enclose the springs to avoid the possibility of a spring being disconnected from its mounting and interfering with the gear meshes. Fig. 14 shows assemblies of precision gearing in a complex control device. Two split spring-loaded gears are used.

Anti-backlash gearing cannot be considered a totally satisfactory solution to the precision gear problem. Although the backlash can be held at zero, tooth wear will destroy the exact contour producing irregularity at tooth frequency and the erosion of material will cause the zero setting to shift in accurately aligned computer equipment.

In high powered equipment where it may be impossible to maintain exact gear center distances and where wear may be excessive, spring-loaded gears

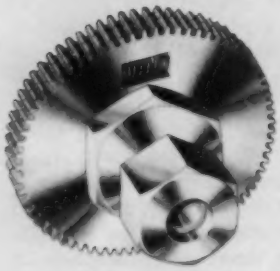


Fig. 13 — Spring-loaded instrument gears manufactured by Servomechanisms, Inc. This type is used in applications where backlash cannot be permitted.

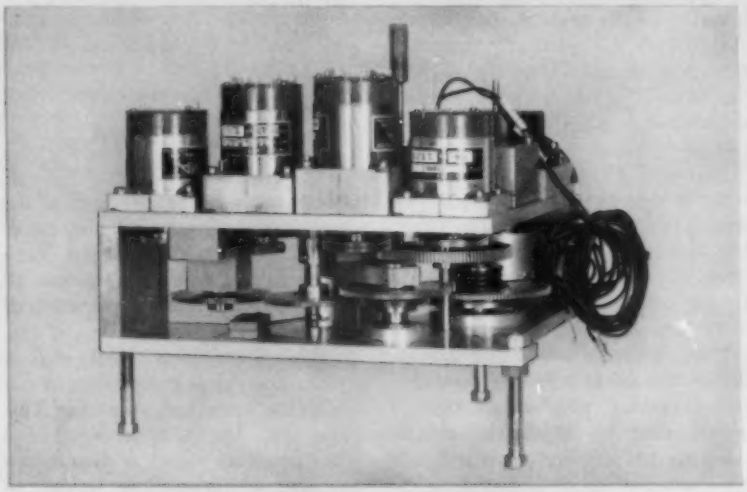


Fig. 14 — Precision gearing used in computing device manufactured by the Arma Corp. Shows use of both conventional and spring-loaded gears.

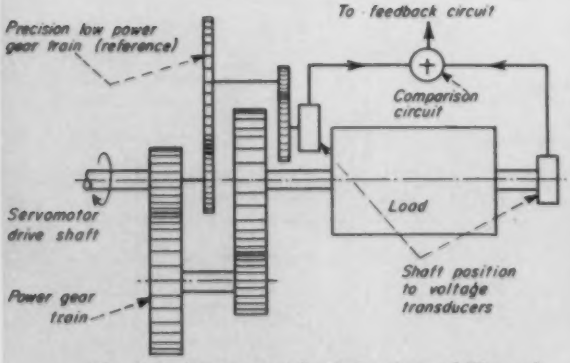


Fig. 15 — Arrangement for improving stability and accuracy of power gear train. The high precision reference gear train permits continuous monitoring of the error in load position. The feedback voltage compensates for backlash.

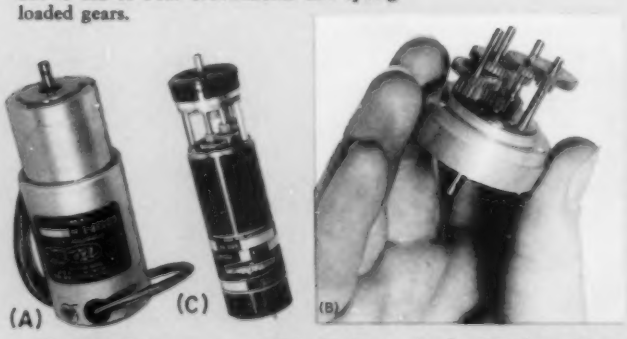


Fig. 16 — Servo motors with integral gear heads. (A) Servo motor manufactured by Eastern Air Devices, Inc. with gear head by Bowmar Instrument Corp. This gear head is shown in (B). Unit has ratio of 314:1. A universal design combination gear head and motor by Servomechanisms, Inc. is shown in (C). First stage pinion is machined directly on motor output shaft.

cannot be used because of their low power efficiency. For these applications a variety of backlash compensation techniques have been developed of which the arrangement shown in Fig. 15 is typical.

This system includes an auxiliary precision gear train that has the same overall gear ratio as the power gear train. The output angular position of this reference gear train is compared with the output angular position of the power gear train or load and the error is introduced into the main feedback loop. This corrects for the inaccuracies in the power gear train and improves system stability.

While this compensating technique is straight-forward and widely applied, it is only useful in large systems where the cost of the additional low power reference equipment is small compared to total system cost.

Practical Factors in Gearing

The factors in selecting gearing for feedback control systems are little different than in the usual high quality gear application. The major differences are in the close tolerances, the minimization of wear to maintain low backlash, the need for frame rigidity to maintain perfect center distances and the transient nature of the tooth loading, where rapid reversal and shock are common. The low static friction requirement often dictates the use of high precision anti-friction bearings and spring loading of the bearings may be necessary to prevent end play.

In many installations, the wide range of environmental conditions may require the use of special lubricants and corrosion resistant finishes. Anodized aluminum gears are frequently used in airborne instrument servos, where the light weight and low inertia features make aluminum superior to the usually preferred brasses and bronzes. A common lightweight combination consists of stainless steel pinions and aluminum mating gears.

Among the most useful of the specialized gear applications are the packaged gear trains built integrally with servo motors, Fig. 16. Because of the compactness of the design and the close control of packaging, these units are economical and accurate. Design simplification and a reduction in system assembly costs can also be achieved by the use of these combination units.

These small instrument servo gear trains are available permanently lubricated, totally enclosed and designed to meet the load and environmental requirements of an application. For minimum inertia and in the interests of economy it has become standard prac-

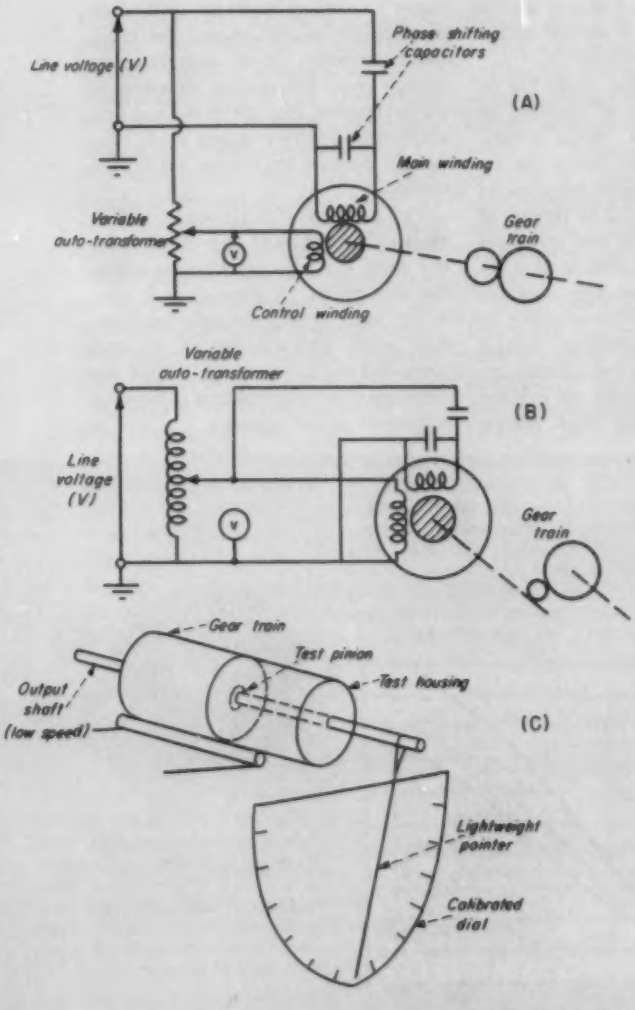


Fig. 17 — Methods of checking gear quality — Servo motor starting voltage is a measure of the sensitivity of the motor — gear train combination to small input signals, and is also a rough measure of gear quality. Since the stall torque developed by a two-phase servo motor varies as the product of the voltages on the two fields, the voltage required to just produce starting is a measure of the friction in the gear train.

In the method shown in (A), full main field voltage is applied to the motor, and torque is proportional to the control field voltage. This arrangement has the disadvanage that it is impossible to separate motor cogging and friction torques from the resistance of the gear train. If the motor rotor is eccentric or if side motion of the rotor is permitted, the rotor will be pulled to one side by the strong main field. This side thrust varies as the square of the main field voltage. This condition will tend to produce high friction points in the gearing and realistically represents the actual situation.

The circuit of (B) is more useful in directly examining the gear friction. Since main field voltage is not at its full value, side thrust is reduced to a negligible amount. This technique gives a relatively true measure of gear friction.

In a good servo motor, v is about 1/20 to 1/50 of rated control field voltage for the first method. In the second method, v varies from 1/5 to 1/10 of rated line voltage.

To use either of these methods, v is slowly increased until the motor just starts. This process is repeated several times and the maximum is the final test figure. By measuring v at different points, any tendency of the gears to bind will be discovered. A convenient way to determine the worst point in a gear train is to slowly reduce motor voltage from a running condition until the motor just stops. The stopping point will generally be a high friction spot. In small servo motors, gear friction as measured at the motor shaft should be about 0.001 to 0.002 oz-in.

A method of measuring gear friction to evaluate a gear trains suitability for assembly with a servo motor is shown in (C). A dummy pinion is made to mesh with the unloaded gear train. The test housing rotates on rollers. In the absence of gear friction, gravity will cause the pointer to remain vertical. Any irregularities in the gearing will cause pointer motion. The pointer can be designed to require a torque of 0.005 oz-in. to deflect it to a horizontal position. Before performing this test the gears should be run in to wear down the high spots and to distribute the lubricant.

tice to cut a pinion directly on the motor shaft. This also permits a maximum gear reduction in the first stage. Gear trains are usually designed to limit the additional system inertia to a fraction of the inertia of the servo motor.

Since the use of integral gear head servo motors is relatively new, little standardization exists and delivery time is often several months. In addition, the cost of the gear head is usually several times motor cost. To improve this situation, some manufacturers are standardizing on gear heads and offering certain discrete ratios as stock items. One manufacturer has designed a gear head having universal jig-bored centers. By using various combinations of 25 stock gears almost any ratio between 4 and 3,000 can be obtained.

For satisfactory performance, the gears must contribute negligible irregularity and starting friction and must not add sufficient coulomb friction to introduce static eror. Also the torque efficiency should be high; a good gear train stage will transmit more than 95 percent of its input torque. Where many gear train stages are cascaded, this loss of torque can present a serious problem.

Rough spots in the gearing and eccentricity resulting in localized loading and high friction will reveal themselves after a 24 hr run-in period, and in critical applications such a run-in is advisable. Local instabilities are characteristic of such gear trains once the high spots have been worn down. A good method of checking gear train quality in a servo is to determine the starting voltage of the servo motor (the minimum signal to which it will respond). Fig. 17 shows two methods of checking servo motor starting voltage, and one method of measuring gear friction.

The gear train precision must be maintained over the entire temperature range of the motor, including its own temperature rise and during transient heating and cooling cycles.

Commercially available motor gear trains have backlash tolerances of $\frac{1}{4}$ to $\frac{1}{2}$ deg. Closer tolerances become very costly.

Often system loop gain rather than torque determines the choice of gear ratio. This is common in instrument servos where a motor is required to drive a stack of potentiometers or resolvers at low speed. In this application, total friction may be of the order of two ounce-inches and gear ratios in the thousands are used.

Where loads have appreciable inertia, it is important that provision be made to limit transient torques on the output shaft and final gear stages. Sometimes a servo design will specify a maximum motor torque on sudden reversal. More often a spring loaded slip clutch will be put on the output shaft as a torque limiting device.

The most precise gear trains are required in the scaling or coupling of computer components. When accuracies of 0.1 percent or better are required in a system, angular inaccuracies of the critical gears must be limited to less than 1 min. In the new computer components having diameters of 1 in. or less, the gear tolerances must be held within 0.0003 in. For example, in multi-speed synchro systems driving computer components, the ultimate accuracy limits are imposed by gearing errors. Fortunately the most precise gearing is required where the speeds are low.

Where magnetic steels such as 416 stainless are used in gears or bearings they can accidentally become magnetized resulting in increasing friction. Simple demagnetization is the solution. However, in sensitive situations this factor and the effects of stray magnetic fields must be considered.

Differential Gearing

In closed loop control systems differentials are used for mechanical comparison or error measurement. They are also used as basic computing elements for the addition or subtraction of two shaft motions, Fig. 18. The selection of a mechanical differential as opposed to an electrical comparison device is a function of design, convenience and price.

A typical computing differential is shown in Fig. 19. This type of unit is designed for highest accuracy of tooth form and minimum friction and backlash. Note that the end gears are customer selected to facilitate application in a specific control system. For maximum economy, some manufacturers classify their differentials according to mesh accuracy. Fig. 20 shows a differential with a hollow output shaft. This feature permits convenient axial positioning.

The accuracy of high quality differentials (about 5 min) is inadequate for the most exacting applications unless the differential is operated at a relatively high speed through precision spur gears. The accuracy of the spur gears and the upper speed limit of the differential represent factors in limiting maximum overall accuracy.

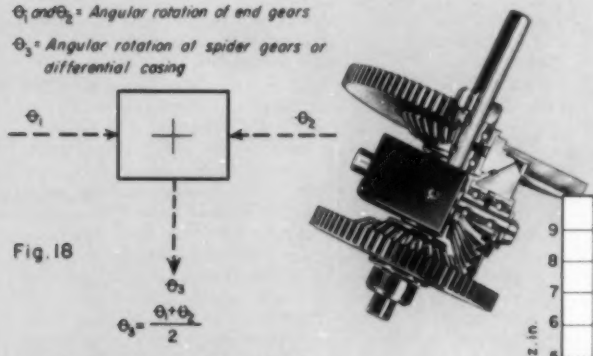
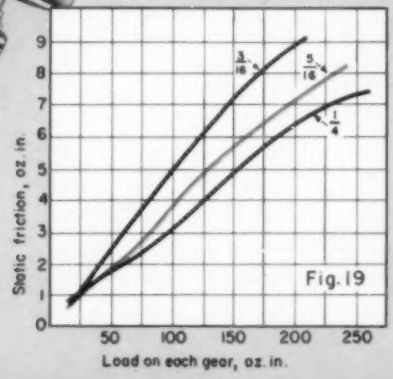


Fig. 18 — Simple schematic of a mechanical differential. In analyzing closed loop dynamics, the speed ratio from the output shaft to the error shaft must be considered in calculating effective loads and loop gain.

Fig. 19 — Cut-away section of single spider gear computing differential manufactured by the Ford Instrument Co. End gears are specified by user to fit the system requirements. Curve shows static friction versus load for three sizes of this type differential.



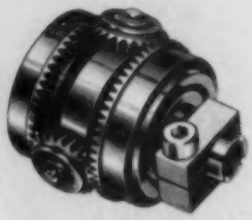
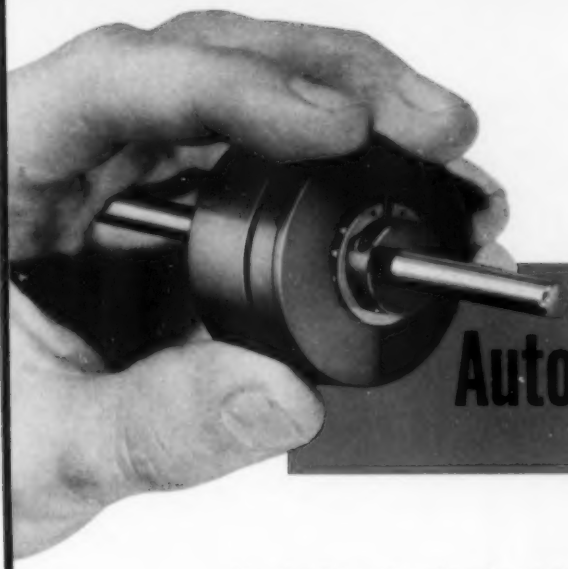


Fig. 20 — Librascope hollow shaft differential including shaft clamp. Unit weighs 1.25 oz with an inertia of 0.0745 oz-in.^{2} Total backlash is less than 10.0 min. Recommended maximum shaft speed is 800 rpm under a maximum load of 6 oz-in.



Automatic Control Clutches

Emphasizing fractional and low integral horsepower applications, which account for a large majority of control applications, the basic requirements for a clutch operating in a closed loop system are defined. As a guide to selection, the characteristics of the specific types that can satisfy these requirements are then presented.

CLUTCHES AND BRAKES are used to control the coupling between two shafts by means of relatively low power signals. In control system applications this coupling can either be of the continuous proportional type where the degree of coupling varies with the magnitude of the control signal, or it can be of the on-off variety where the coupling is either zero or maximum.

The principal types of clutches that are of interest to control system designers are electrically operated friction disk, hysteresis, eddy current, magnetic fluid, magnetic powder, crystal, and "loudspeaker" clutches. While the specific features of each clutch will be covered in detail in a later section, all of these types of clutches or brakes must have the following characteristics to perform satisfactorily in closed loop applications:

a. Smooth coupling throughout the specified speed range and ease of control by electrical signals.

b. Rapid response to prevent time delays that can cause instability.

c. Low control power required for actuation.

d. Minimum stickiness or hysteresis in the response of the output to a control signal.

e. Minimum zero signal clutch torque, since residual torque can cause system errors and heating.

f. Sensitivity to small error signals.

g. Linearity of output response to control signal is often desirable but usually not absolutely necessary.

Clutches are not widely used in the small instrument servos where the controlled power is under 10 or 20 watts since the additional hardware represented by the clutch increases the packaging problem and the cost. Exceptions are made in certain specialized applications where high response speed is required.

Where the power level exceeds this low figure, clutches are widely used in control systems that range in size up to thousands of horsepower. The clutches and applications presented here emphasize the low integral and fractional horsepower ranges. These cover the majority of the clutch application problems.

Some typical control applications of clutches (or brakes – essentially similar to clutches in design and appearance except that output shaft is held stationary) are precise rapid positioning, synchronizing of shafts, speed control, rapid cycling, and rapid starting and stopping. The technical advantages that make clutch control suitable for these types of applications are:

a. High intermittent torques can be obtained.

b. Reduced control power requirements mean that excitation can be supplied by a low power amplifying device.

c. High accelerations of several hundred thousand radians per sec^2 can be obtained by abruptly coupling a high inertia rotating flywheel to a load. This exceeds the accelerating ability of electric motors and is comparable to the performance of high quality hydraulic drive units.

d. Suitable clutches can reduce shock loading such as can occur during synchronizing of a control system.

e. A single drive motor can be used to drive several loads in turn through a suitable clutching arrangement.

f. Clutch application flexibility permits a large variety of special purpose circuits to be constructed.

g. All of the listed types of clutches can be controlled remotely.

Since a clutch is not a source of torque, but rather a transmitter of torque, it controls speed by reducing the input speed from a prime mover to the desired level. The method by which this is accomplished necessitates the absorption of energy by the clutch. Thus a clutch, when slipping, generates a large quantity of heat. This often means that elaborate cooling methods must be used, and a part of any clutch selection problem involving speed control is a consideration of the heating effect. This must include an examination of the duty cycle and the inertial and/or dissipative characteristics of the load. Heat dissipation is of maximum concern in clutches that require the slipping of coupled friction disks,

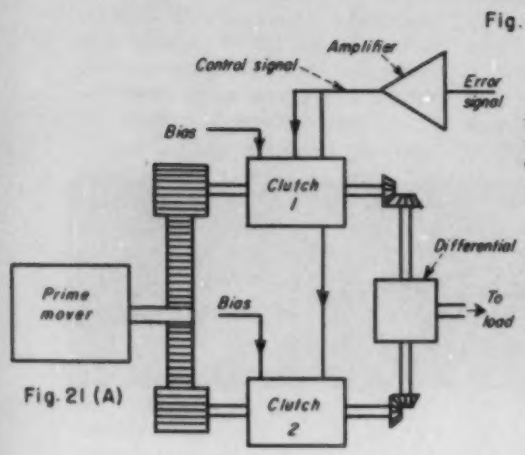


Fig. 21 (A)

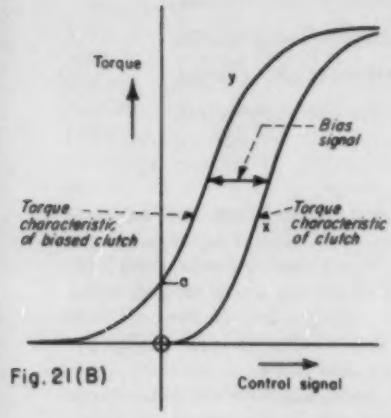


Fig. 21 (B)

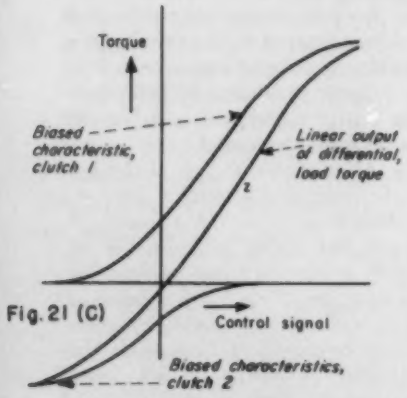


Fig. 21 (C)

Fig. 21 (A) — Schematic of a clutch type bi-directional actuator for use in control systems. Linear performance is obtained by biasing both clutch control coils and using a push-pull amplifier. (B) — Typical nonlinear clutch characteristic, *X*, and same characteristic after the application of a bias signal to the control coil, *Y*. (C) — Two biased clutches combined as shown in (A) give a resultant output curve, *Z*, that is linear over a specified range.

Fig. 22 (A)

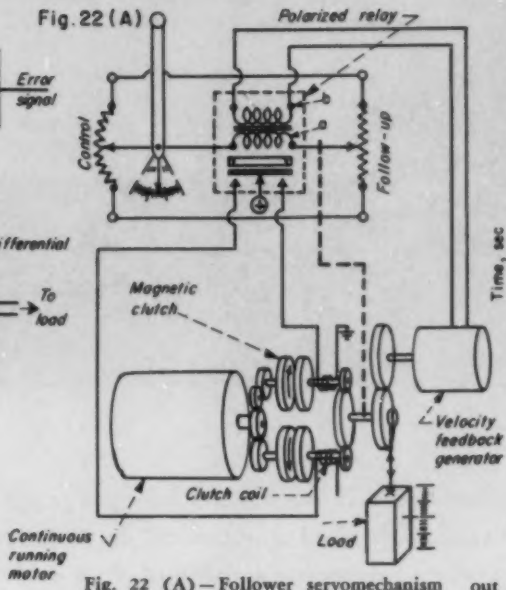


Fig. 22 (B)

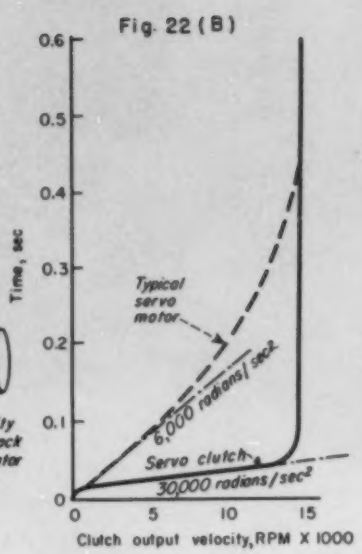


Fig. 22 (A) — Follower servomechanism driven by a relay operated clutch system. The use of velocity feedback results in a continuous high frequency chatter around the closed loop that effectively averages out the nonlinearity of the clutch. (B) — Comparison of system response using a servo clutch and a typical servo motor. The clutch drive unit is capable of five times the acceleration of the servo motor.

where heat is localized and wear is high.

In analyzing the torque and dissipation requirements of a system, each mode of the cycle must be considered and the results determined by the application of conventional dynamics. Most manufacturers provide curves relating steady torque and dissipation to slip.

Linearity Characteristics of Clutches

In continuous closed loop operation is is usually desirable to achieve effectively linear performance with a clutch. If a clutch is inherently linear (in other words, if the amount of coupling varies directly with the magnitude of the control signal), it can be combined in a servo system in much the same manner as the other servo components. If a clutch is nonlinear, the techniques that are used to obtain essentially linear response are varied and depend on the specific nature of the clutch. However, there are two basic approaches to this problem.

The first approach includes those clutches that can reasonably be considered approximately linear. With these clutches a further improvement towards linearity is obtained by using special devices such as push-pull operation or biasing. A typical circuit using this mode of linearization is shown in Fig. 21 (A). The bi-directional assembly is driven by a push-pull amplifier (which can also supply the clutch bias as quiescent plate current) and gives highly linear performance in a servomechanism.

The principle of operation of this circuit is shown by the curves of Figs. 21 (B) and (C). The basic operating mode of the clutch is represented by the nonlinear curve, *X*, of Fig. 21 (B). The application of a bias signal to the clutch control coil shifts this basic curve to the left, curve *Y*, so that with no control signal the clutch will deliver a torque represented by point *a*. Fig. 21 (C) shows the result of combining two clutches, each biased an equal amount. The no-signal torques of the two clutches cancel one another and the application of a control signal will cause a linear response of torque as shown by curve *Z*. Clutch operation is designed to be sensitive to control signal polarity.

Where a clutch behaves essentially in an on-off manner (for example, the usual frictional surface type), there is another general method for achieving linear performance. This method requires the introduction of a system oscillation of high frequency compared with the natural frequency of the system and is similar to the methods used for linearizing relay or on-off type amplifiers. The oscillation can be intro-

Table I—Clutch Types and Characteristics[1]

Type	Power Rating	Time Delay[2] Milliseconds	Nature of Control	Power Gain[3]	Durability
Friction disk	250 watts	5	On-off	200	Fair
Hysteresis	Low hp	3	No slip, continuous control	5-20	Excellent
Eddy-current	Up to thousands of hp	10	Slips several per cent continuous control	50-200	Excellent
Magnetic fluid	250 watts	3	Continuous control, nonlinear torque curve	200	Good
Magnetic powder	250 watts	3	Continuous control, nonlinear torque curve	200	Good
Crystal	25 watts	0.2	On-off, poor ratio of idling to rated torque	Many thousand	Fair
Loudspeaker	25 watts	0.5	On-off	—	Excellent

Notes: 1. Because of diverse nature of possible applications, characteristics are given for typical rather than extreme applications.
2. Time delay figures apply when clutch is operated from a high impedance excitation source.
3. Power gain is for closed loop control applications.

duced from an external source or can be generated internally by suitable feedback circuits.

When a control signal is superimposed on this high frequency oscillation, either the positive or negative half cycle of the oscillation is accentuated, depending on the polarity of the signal. This results in a net average value of direct control and the average control force is approximately proportional to the control signal over a useful range, even though the clutch itself is inherently highly nonlinear.

In Fig. 22 (A) is shown a typical follower servomechanism operating in this mode. The control signal input to this system is through a bridge network consisting of a variable control potentiometer and a variable follow-up potentiometer. Any unbalance in the bridge will cause a current of the proper polarity to flow in relay actuating coil *a*, energizing the proper clutch coil to rebalance the bridge. Thus load position is determined by control potentiometer position, and load position is mechanically fed back to the follow-up potentiometer to balance the circuit.

To introduce the high frequency oscillation necessary to linearize clutch operation, a velocity feedback generator is geared to the output shaft of the double clutch unit. The output of the generator feeds an auxiliary coil, *b*, on the polarized relay so that the direction of relay actuation bucks the direction of load movement. In the presence of a small error signal on relay coil, *a*, a high frequency system oscillation is set up that alternately energizes one clutch and then the other to maintain the correct average load position. The proper clutch is energized a greater portion of the time depending on signal polarity. If the control signal is large enough, only one clutch will be energized and the load will be slewed at maximum rate to the null position. Fig. 22 (B) shows the improvement in response time that is possible with a clutch servomechanism compared to the response of a typical servo motor.

Since this latter mode of operation can be used with sturdy, inexpensive and fast-acting friction disk clutches that are capable of handling large forces in small sizes, it has found applications where compactness and cost are important. The accuracy of this arrangement is comparable to that obtained from high performance linear systems. However, the rapid oscillation characteristic of this mode of operation means increased wear, relatively short life, and reduced net amplification as compared with the nonoscillating direct-acting system.

To show the variety of uses for clutching devices (including brakes) in closed loop systems, Fig. 23 covers four typical schematic application diagrams. The choice of the type of clutch to be used in one of these applications depends on the specific load and duty requirements.

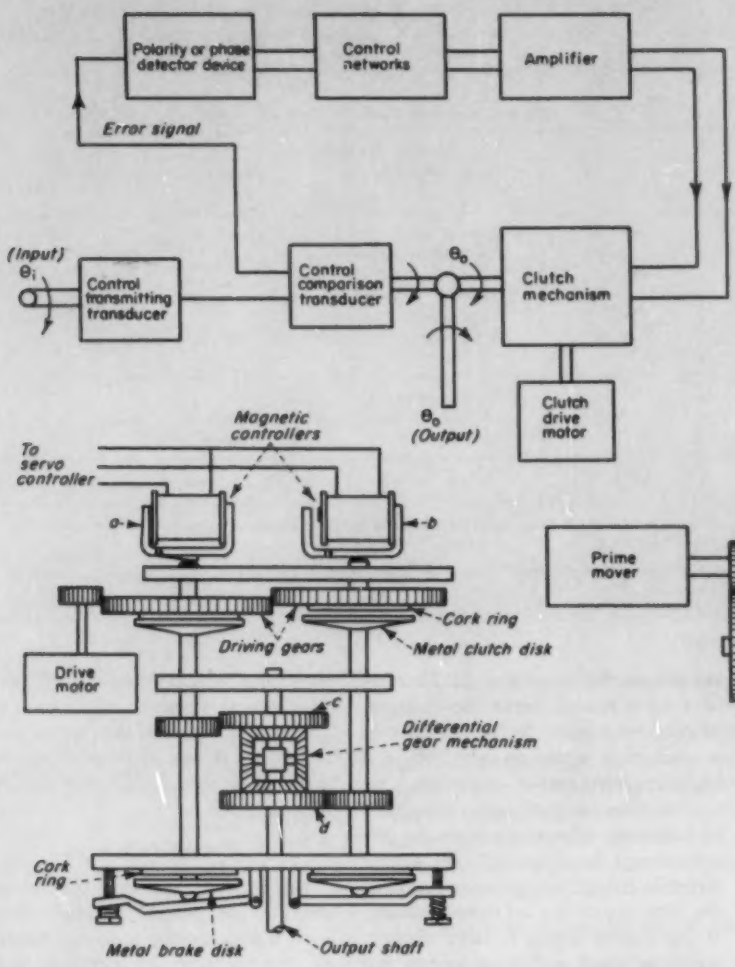
Types of Clutches

Magnetically operated friction disk clutches are general purpose components and constitute the large majority of clutches that are presently being used in automatic control systems. While wear at the friction surfaces can cause failure by the destruction of the clutch faces or by excessive gap increase, satisfactory life for many applications is obtained through the suitable choice of friction materials.

Good wear properties have been achieved by using combinations of steel against steel. Case hardening and chrome plating will increase the life. Also, stainless steel has been satisfactorily used with case hardened steels.

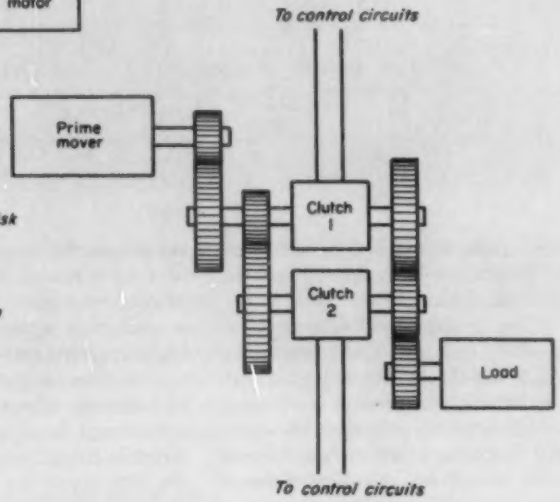
This type of clutch is compact; operating characteristics can be predicted in the design stage; and it can be designed into integral assemblies with servo actuators and other devices. Units are available for control system applications with response times of 5 milliseconds and better. Power amplifications of several thousand can be obtained with carefully designed magnetic circuits.

Fig. 23—Clutch Application Diagrams

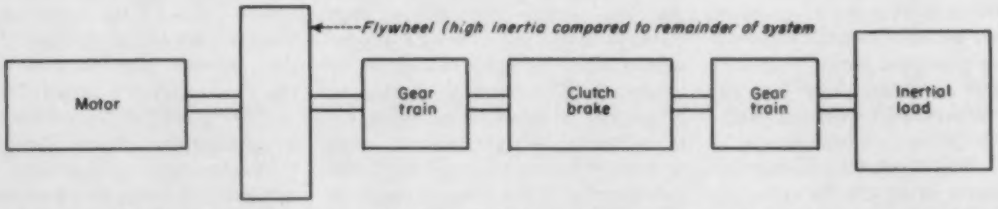


(A) (left) — General schematic of clutch-type instrument servo. This system is similar to a conventional closed loop positioning servo with the exception that output position, θ_o, is adjusted by varying the excitation to the clutch mechanism, which is driven by a continuously running drive motor, rather than by directly varying the input to a servo motor. If the type of clutch used is not inherently linear, one of the modes of operation discussed previously can be used to obtain a linear response.

(B) — Detailed schematic of a clutch type instrument servo manufactured by Norden. This system incorporates simultaneous clutching and braking. In the diagram, magnetic controller *a* is energized. This engages the clutch from the driving motor and disengages the brake for the left hand shaft, by axially shifting the shaft. Thus the output shaft is being driven by the left hand shaft through differential gear *c*. Since only one controller can be energized at a time, the right hand shaft is held stationary by its brake. This means that gear *d* is locked so that the differential can be driven through gear *c*. This arrangement permits rapid starting and stopping.



(C) — This diagram shows two clutches used to obtain two-speed operation. This is a simple on-off arrangement that is useful in multiple-mode servo systems.



(D) — Schematic of system that is useful for rapid starting and stopping. When the clutch is energized, the load is coupled to the high inertia flywheel and motor. This resuits in high load accelerations. When the clutch is de-energized, the load is disconnected from the flywheel and motor and is coupled to the brake. This brings it to a rapid stop. The flywheel supplies pick-up energy during acceleration.

This high gain permits the control of integral horsepower loads from conventional small receiving tubes.

The operation of this clutch is decidedly nonlinear, since it is essentially an on-off device. For use in proportional systems, the high frequency linearizing technique described above can be applied.

In Fig. 24 (A) is shown a typical high power capacity friction disk clutch and brake combination. In this unit both the brake and clutch are magnetically actuated, with the clutch actuating coil being through slip rings from the brushes. The speed-torque curves and speed-power dissipation curves for various sizes of this unit are plotted in Figs. 24 (B) and (C). These curves are necessary for predicting system performance and for sizing the clutch to meet specific duty cycle conditions.

Another type of brake-clutch combination is shown in Fig. 25. In these devices the clutching function is obtained by the use of a conventional magnetic actuating coil, while the braking function is spring-actuated and operates whenever the clutch coil is deenergized. This unit is useful for rapid start-and-stop operation shown in Fig. 23 (D) and is especially useful in servos where the motor rotor constitutes the bulk of the system inertia.

One manufacturer produces a flexible brake-clutch combination that uses various arrangements of crown tooth coupling and/or friction plate coupling in the standard housing shown in Fig. 26 (A). The types of drive and brake arrangements that are available are

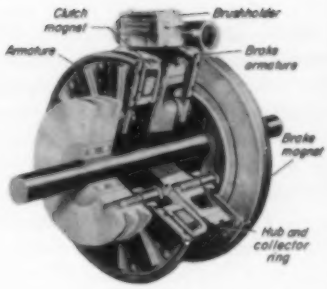
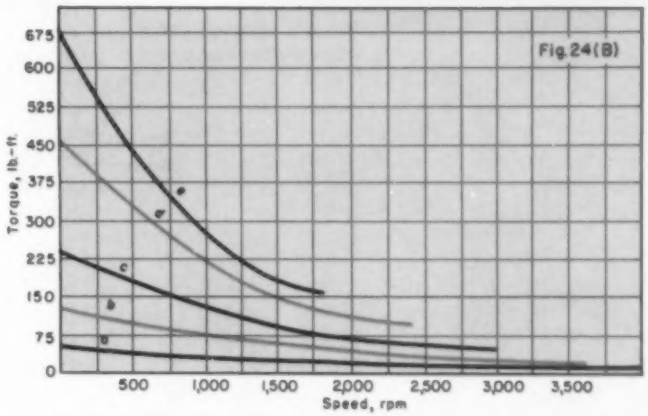
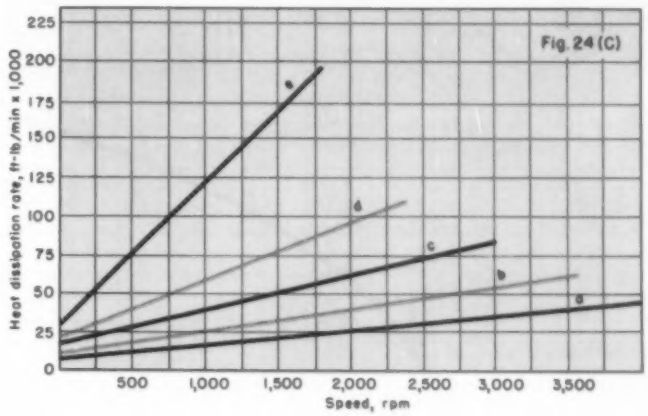
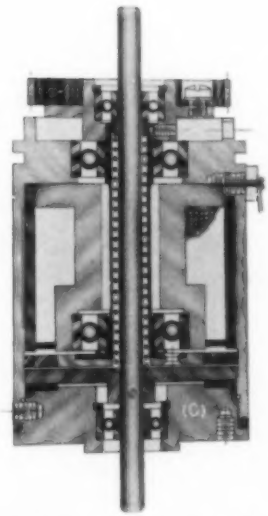


Fig. 24 (A) (left) — Friction type magnetically actuated brake and clutch combination manufactured by the Warner Electric Brake and Clutch Co. (B) (below) — Torque-speed curves for various sizes of clutch shown in (A). These curves are important in establishing clutch rating and in predicting the dynamics of a clutch actuated system.







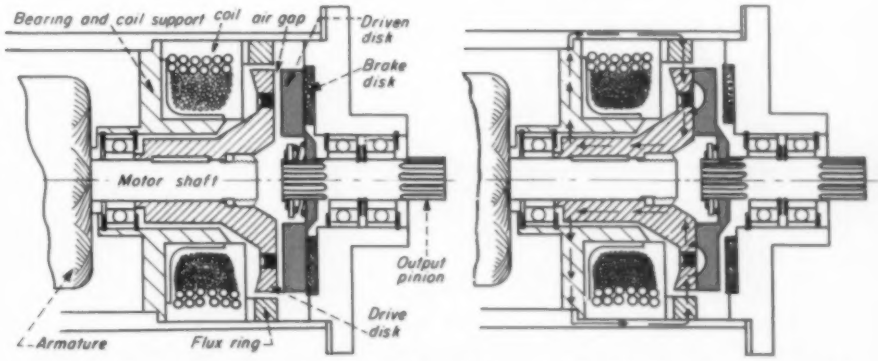


Fig. 25 — Fastop clutch-brake unit for servo use by Lear, Inc. In (A) (center) the clutch is deenergized and the load is coupled to the brake. The motor is disconnected and coasts to a halt at will. (B) (right) shows the clutch energized so that the motor drives the load. (C) is a similar type of clutch-brake combination manufactured by the Belock Instrument Co. Unit is designed for use as a separate element in a control circuit.

shown in Fig. 26 (B). The crown tooth coupling is used where a high torque must be transmitted with no slip, while plate (friction disk) coupling is used where the clutch or brake must engage in any contact position without angular shaft displacement. This latter arrangement also has the torque limiting feature in that the clutch or brake will slip if a certain peak torque is exceeded. Fig. 26 (C) shows the relation between static torque and control voltage for the crown tooth type of coupling.

Hysteresis Clutches

In the hysteresis clutch, d-c control excitation generates a steady field in the clutch, Fig. 27. The flux passes through and magnetizes the permanent magnet ring. Because of hysteresis, the resultant flux poles generated by the ring lead the axis of d-c excitation by some angle. This angle depends on the control excitation and on the choice of permanent magnet material. The attraction between the induced poles of the

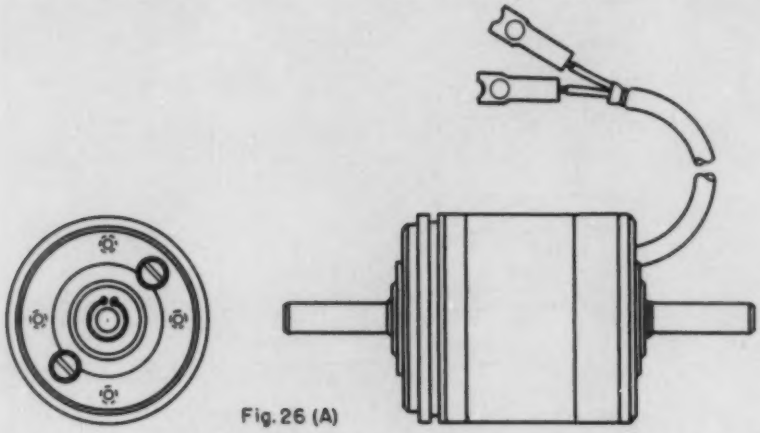


Fig. 26 (A)

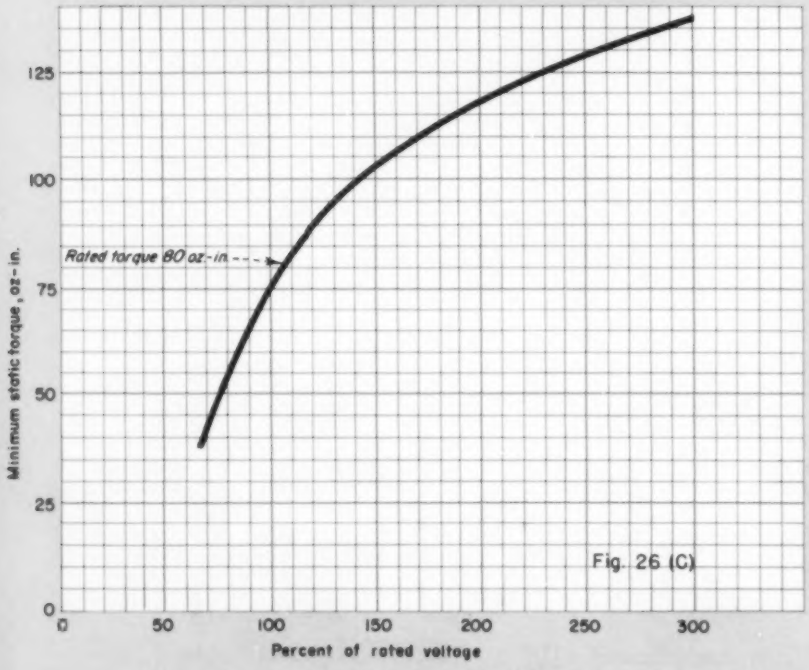


Fig. 26 (C)

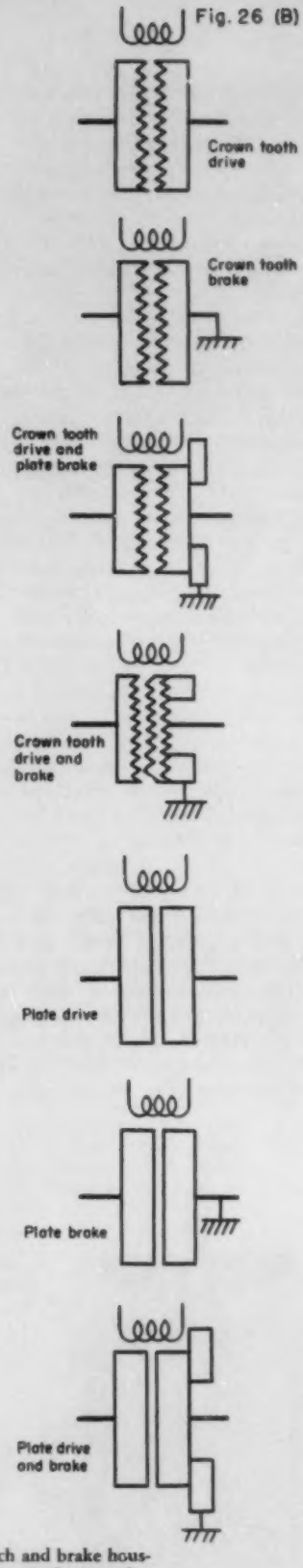


Fig. 26 — (A) (left, above) Reeves Instrument Corp. standard magnetic clutch and brake housing for control and instrumentation applications. Crown tooth type will transmit 80 oz-in., while plate type will transmit 16 oz-in. (B) (right) shows various arrangements of crown tooth coupling and plate coupling that can be obtained in housing shown in (A). Curve in (C) (above) is plot of static torque against rated voltage for crown tooth coupling. Rated value is shown to be 80 oz-in.

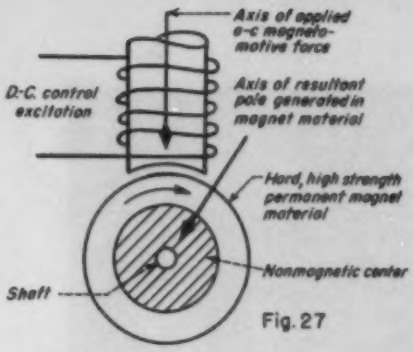
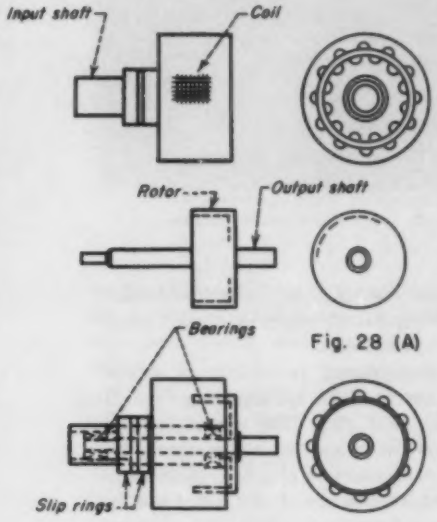

Axis of applied a-c magneto-motive force
D-C. control excitation
Axis of resultant pole generated in magnet material
Hard, high strength permanent magnet material
Nonmagnetic center
Shaft
Fig. 27

Fig. 27 — Schematic diagram showing operating principle of hysteresis clutch. Torque is developed as a result of the angle of lag between the pole generated in the ring and the axis of the applied d-c excitation.



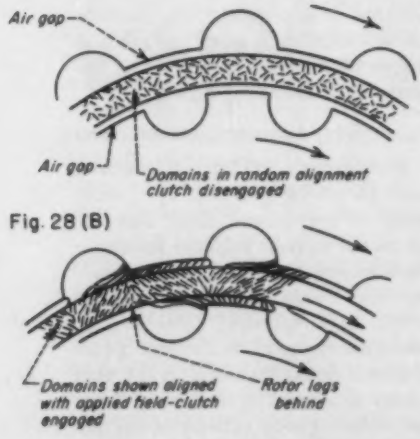


Fig. 28 (A) — Component parts of a typical hysteresis clutch manufactured by Magtrol, Inc. (B) shows clutch performance for the disengaged and engaged conditions. When control excitation is applied, the magnetic fields between the input and output members will resist relative motion of the members. This produces an output torque.

ring and the control magnetomotive force results in a torque opposing rotation. Quantitatively, the torque can be deduced from the fact that the work done in turning the rotor must equal the hysteresis loss in the rotor iron.

A hysteresis clutch has the following characteristics:

1. Power gain is low; usually ranges from about 5 to 20.

2. Hysteresis torque is independent of speed. (In an actual unit, induction torques may also be developed because of rotational eddy current losses in the permanent magnet ring. These torques can be of the order of 3 to 10 percent of total torque per 1,000 rpm).

3. Operation is smooth because of the perfect symmetry of the rotor design.

4. Residual drag at zero excitation is low.

This type of clutch permits close control and can carry full load with no slip and consequently no heat generation. When slipping under overloads, heat is generated proportional to slip. The power dissipated is equal to the product of torque and slip speed. Dissipation limits the upper operating speed of the hysteresis clutch.

The unit is reliable and stable, maintaining its initial performance indefinitely. It can be used as a torque-limiting cushion against shock loads, and the uniform torque characteristics have resulted in its application in tension control devices. Because of its flat characteristic, the hysteresis clutch cannot be used in speed control applications unless the load has a sharply rising speed-torque curve.

In special designs the hysteresis clutch can be built with torque to inertia ratios of 50,000 rad/sec^2 or higher, with time constants of the order of a few milliseconds.

Although a hysteresis clutch is capable of developing speed independent torques, it cannot be used where a duty cycle includes small rapid reversals, for example, in damping backlash oscillations. During reversal a dead zone is encountered before the opposing torque builds up.

In Fig. 28 (A) is shown the component parts that form a typical hysteresis clutch. The output or rotor assembly is driven by the input assembly through air gaps by an applied magnetic field. The output rotor is constructed from a permanent magnet material. The input assembly consists of two multi-polar members arranged so that all poles of each are of similar polarity. The permanent magnet rotor is assembled into the circular opening between these members and is itself polarized by the applied field that is driven through the air gaps and the permanent magnet rotor when excitation is applied to the coil through the slip rings.

Clutch operation is shown in Fig. 28 (B) for the energized and de-energized conditions. The magnetic domains within the rotor ring are caused to align with the controllable flux path

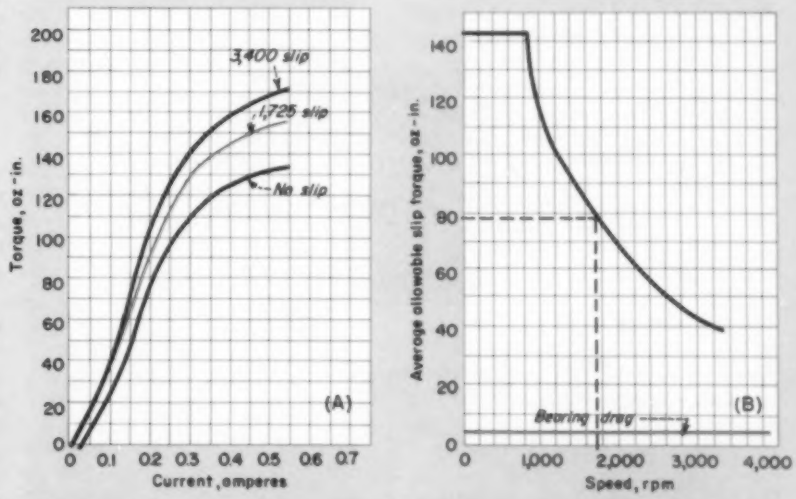


Fig. 29 — (A) (left) Maximum transmitted torque versus excitation current for hysteresis clutch manufactured by Duncan and Bayley. Three conditions of slip are shown. In (B) (right) is shown average allowable slip torque as a function of slip speed. Dotted lines indicate that for difference in speed between input and output of 1,725 rpm, the continuous torque must not exceed 80 oz-in.

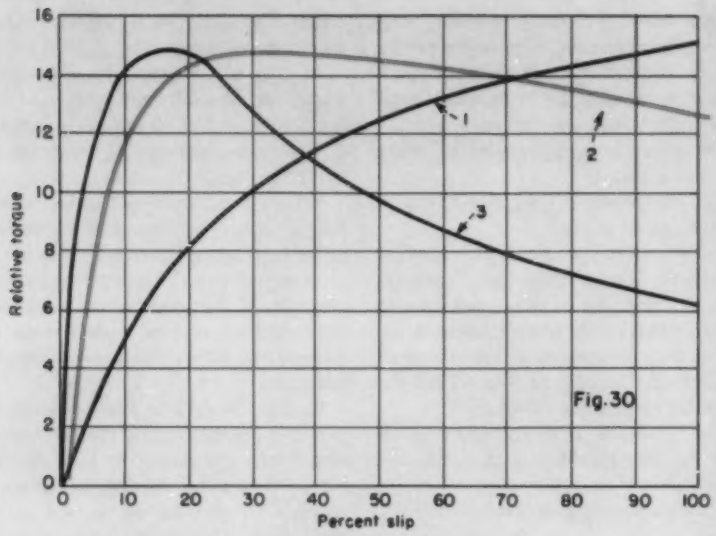
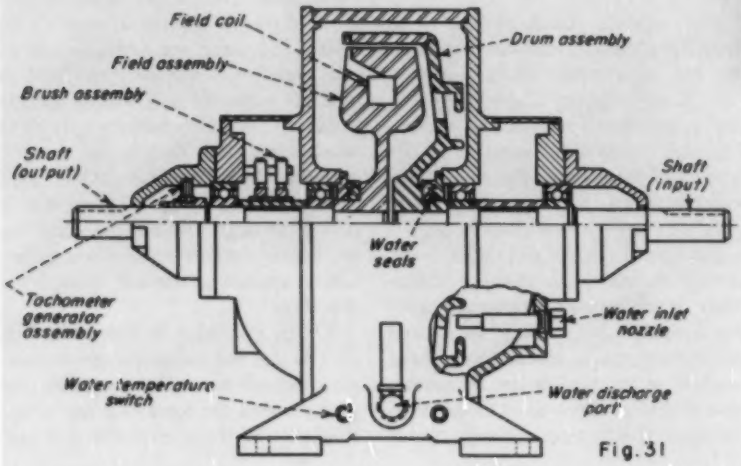
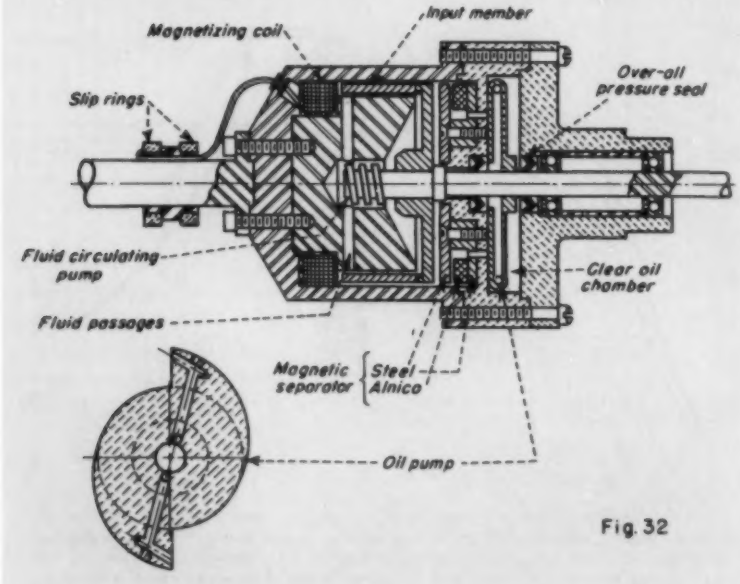


Fig. 30 – Typical shapes of slip-torque characteristics for three types of eddy-current clutches manufactured by Dynamatic. Various characteristics are obtained by modifying the pole design of the d-c field.

Fig. 31 – Cross-section of Dynamatic water-cooled eddy-current clutch. The unit incorporates a tachometer generator for use as the feedback element in a closed loop velocity control system. Speed can be controlled to 0.1 percent over speed ranges exceeding 5 to 1.

Fig. 32 – Hermetic seal for magnetic fluid clutch developed by the National Bureau of Standards. Clear oil from a reservoir is continuously pumped into the interior of the clutch. The clear oil is then returned to the reservoir through a magnetic separator that prevents passage of the iron powder.





across the air gaps. Unless overloaded, the input and output units will rotate in synchronism.

Performance curves for a typical hysteresis clutch are shown in Figs. 29 (A) and (B). The curves in (A) show the torque that can be transmitted as a function of clutch excitation current for a condition of no slip and for two different slip speeds. (B) indicates the average allowable slip torque as a function of slip speed. Note the relative insensitivity to speed and the high degree of linearity for excitation currents below saturating values.

Eddy-Current Clutches

Eddy-current braking and clutching units are available in sizes up to thousands of horsepower. Since there are no contact surfaces required for torque transmission, these devices are reliable and have infinite life characteristics.

The basic operating principles are somewhat analagous to those of a conventional induction motor. A d-c field rotates relative to a conducting material, inducing eddy currents in this material and generating a drag torque. In an eddy-current clutch, torque is a function of slip and unlike the hysteresis clutch, torque cannot be developed unless there is a difference in speed between the input and output members. It can be shown from induction motor theory that the relation between the in-

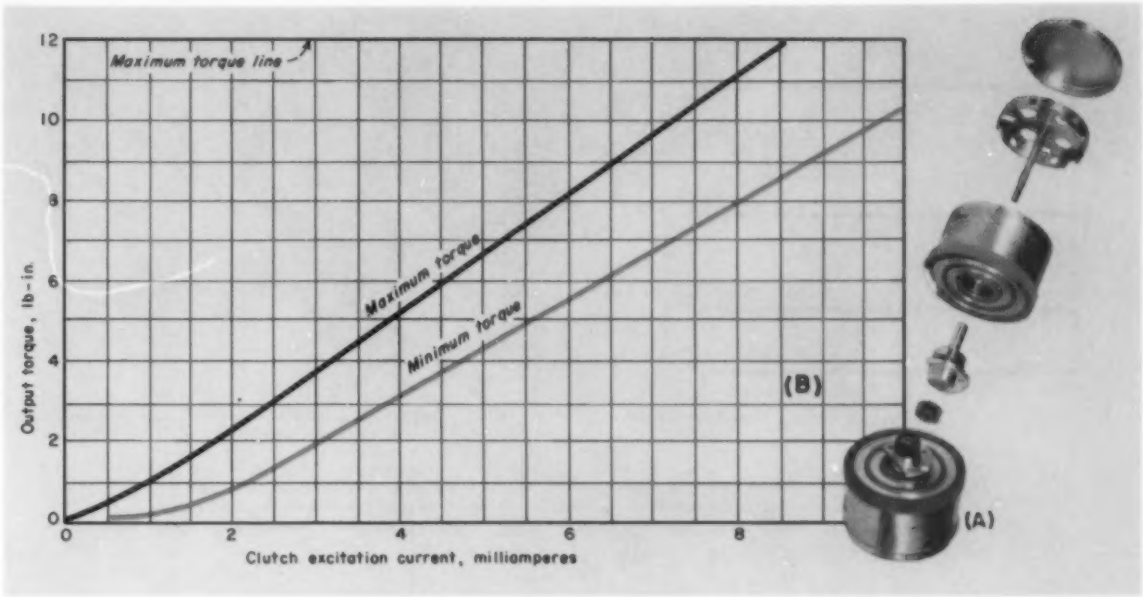


Fig. 33 (A) – Exploded and assembled views of Lear magnetic powder clutch for servo applications. Torque is transmitted between pinion on inner shaft and gear machined on casing. (B) shows the torque versus excitation current characteristics for this unit. Except at low signal levels, clutch performance is extremely linear.

herent eddy-current losses generated in the conducting material and the developed shaft power can be expressed as follows:

$$\frac{P_{EC}}{P} = \frac{\text{slip}}{\text{speed}} \qquad (31)$$

where

P_{EC} = eddy-current loss
P = shaft power to load
Slip = speed difference between input and load
Speed = load speed

For maximum clutch efficiency, the slip must be small. For a given output torque, slip is determined by the slip-torque characteristics of the clutch. The shape of the characteristic curve is dependent on machine design parameters. As with conventional induction machines, both low slip units and high slip units are available. While the latter type is low in running efficiency it is capable of developing high starting torque. Fig. 30 shows performance curves for three types of clutches. Note that the high slip clutch, 1, develops a much high starting torque (100 percent slip) than the low slip clutch, 3.

The control power required for eddy-current clutches varies from several percent of the output power in the small sizes to a fraction of a percent in large units. Since both the d-c flux and the induced eddy currents increase with control current (neglecting saturation), the drag in eddy current clutches varies as the square of the control current. While this feature is somewhat undesirable in feedback control systems, it does not prevent the use of these clutches in this type of system.

The efficiency of this type clutch compares favorably with that of Ward-Leonard drives and other speed control systems, particularly at low slips. The efficiency of an air-cooled clutch is approximately equal to that of a wound rotor induction motor of equal rating. Typical units, Fig. 31, slip between 1.5 and 5 percent at rated loads.

In large systems, a wide range of speed control can be obtained by using feedback control of the d-c field. In the very large sizes, water cooling is used. One manufacturer circulates water between the rotating members so that in addition to cooling directly at the heat source, extra drag is obtained because the water is subjected to shear. Efficiencies as high as 96 percent can be obtained in this manner.

Magnetic Fluid and Magnetic Powder Clutches

These clutch types consist basically of a pair of plates separated by a powder or powder-oil combination of finely divided magnetic particles. The application of a magnetic field causes the powder to form a rigid mass capable of transmitting torque and oriented along the lines of flux. While the fluid type operates more smoothly, maintains more uniform distribution of the iron particles and has superior cooling characteristics, leakage caused by inadequate sealing techniques has in many instances forced the use of the dry powder.

The slipping action that occurs under load, while it generates the usual heat inherent in slip clutches, does not cause excessive wear since the sliding iron particles and all interior surfaces of the clutch are lubricated. Lubricants based on talc or molybdenum have been used successfully in dry powder units.

Labyrinth seals have been employed in magnetic clutches, with varying degrees of success. If the speed of the clutch is always high, the labyrinth can be made effective by utilizing the centrifugal forces on the powder. Where the speeds are variable and the positions of the clutch are undetermined, as in some military airborne applications, the use of labyrinths has not proved satisfactory. Labyrinths, moreover, do not prevent breathing. Thus, as the clutch warms up, air is driven out, and as the clutch cools, cold air enters again, carrying with it fresh oxygen and moisture, which corrode the internal parts of the mechanism and the iron powder.

For these reasons, hermetic sealing is often used. One type of hermetic seal, Fig. 32, consists of a reservoir of

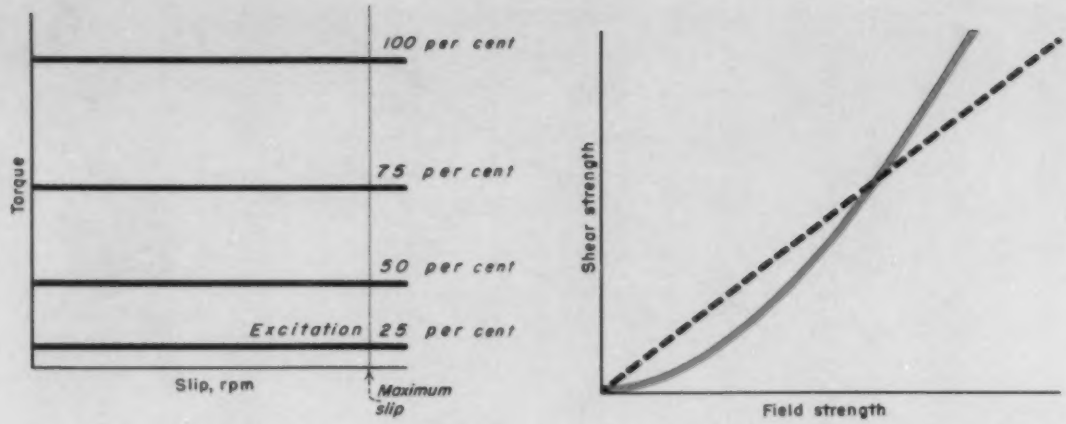


Fig. 34 – (A) (left) Slip-torque characteristics of Clark Dynamatic magnetic powder clutch. Family of excitation curves are flat out to maximum allowable slip. (B) indicates the field-shear variation of same unit. Dotted line represents desired linear performance, while solid line represents actual clutch performance.

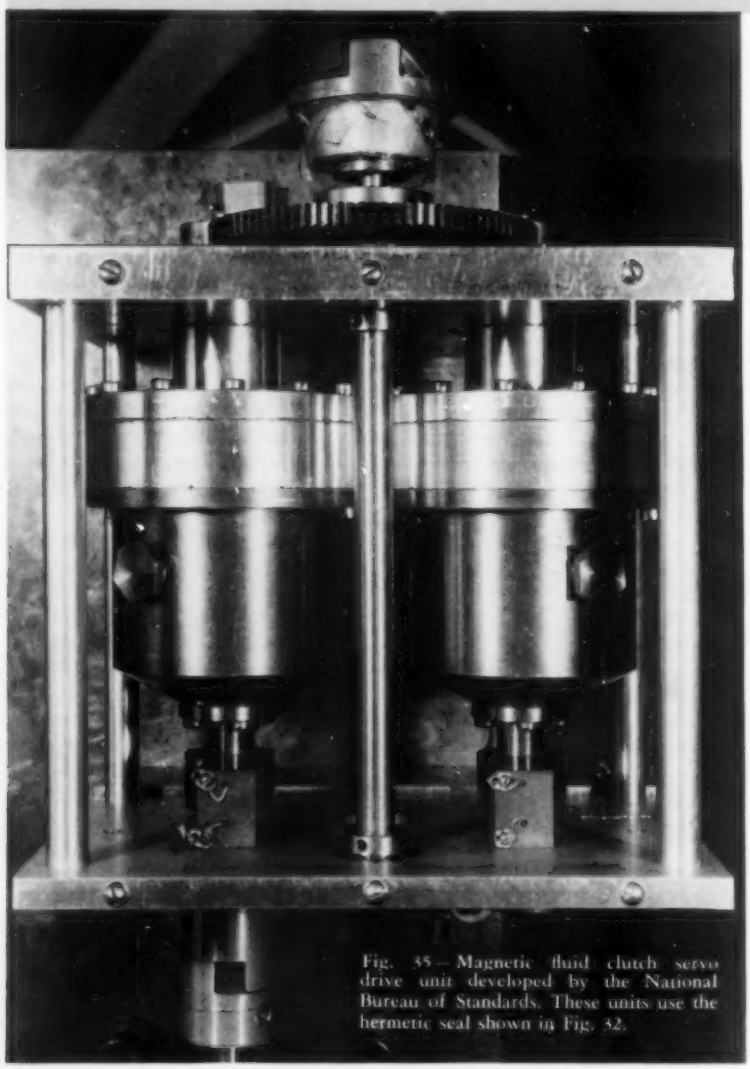


Fig. 35 – Magnetic fluid clutch servo drive unit developed by the National Bureau of Standards. These units use the hermetic seal shown in Fig. 32.

clear oil, mounted adjacent to the clutch proper, so designed that the clear oil is continuously pumped along the shaft into the interior of the clutch. The clear oil is then returned to the reservoir through a magnetic separator which prevents iron particles from flowing with the oil. The magnetic separator consists of a ring magnet of Alnico having a short air gap. The iron powder does not pass the air gap, while the oil does so freely. An impeller-type pump then recirculates the oil back through the shaft seal. The whole system is provided with a second seal which operates entirely in clear oil. Such seals are commercially available.

When thick grease lubricants are used in magnetic fluid clutches, the sealing problem is somewhat simpler since the iron-grease mixture tends to stay in the working gap. Air intake, however, causes trouble, and hermetic seals are still required to make the clutch independent of ambient conditions. This is also true of clutches employing dry lubricants.

In Fig. 33 is shown an exploded and an assembled view of a typical magnetic powder clutch for servo applications, and the torque-excitation current characteristic for this clutch. This unit transmits a normal torque of 0.8 lb-in. with a maximum rating of 12 lb. in. at a maximum recommended speed of 1,500 rpm. With a 100 percent slip, the maximum continuous frictional power dissipation is 15 watts. With zero ex-

Fig. 36 — Experimental crystal clutch designed by National Bureau of Standards. The three crystal elements bend when a d-c voltage is applied. This bending pinches the output disk between the rotating mounting plate and the rotating crystal pressure plate.

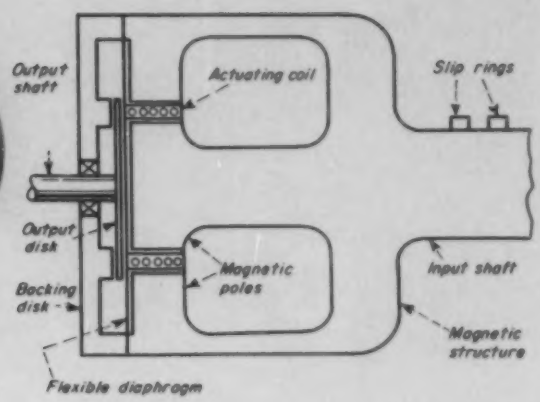


Fig. 37 — (right) Schematic diagram of National Bureau of Standards loudspeaker clutch. When current is applied to the actuating coil, which is located in a magnetic field, the coil moves forward and presses a flexible diaphragm against a disk attached to the output shaft.

citation the drag torque is 0.2 lb-in. maximum. By using forced air cooling, increased energy dissipation ratings can be obtained.

The perfomance characteristics of Fig. 33 (B) show the ordinary production variations. The slight nonlinearity at low signals can be overcome by biasing. This bias can be obtained from the quiescent plate current of the driving amplifier tube.

The torque-slip characteristics of another commercially available magnetic powder clutch are shown in Fig. 34 (A). The uniform flat characteristic is similar to the characteristic obtained with a hysteresis clutch. However, the power amplification of the magnetic powder clutch is inherently higher.

The flatness of the curves indicates that no velocity lag will be introduced in a simple servomechanism during tracking. This is in contrast to the lag that is inherent in the speed-torque curves of a conventional two-phase servo motor. Fig. 34 (B) shows a plot of shear strength versus field strength for this same unit. The dotted line in this curve represents the desired linear performance. The solid line is actual clutch performance. While the nonlinearity is objectional, where necessary, push-pull circuits can be used to minimize this effect.

In Fig. 35 is shown a servomechanism power unit using two magnetic fluid clutches driven by a constant speed motor.

Crystal Clutches

The crystal clutch is actuated by a direct current applied to a piezo-electric crystal. This causes a change in the dimensions of the crystal, pressing the clutch output disk against the input disk. The unit is noted for its high speed of response and negligible current drain. Although not widely used as yet, these features make the crystal clutch valuable in a few specialized closed loop control applications.

Since the only excitation current that is required is the insulation leakage current necessary to charge the crystal capacitors, current drain is negligible. There is no magnetic field generated. One model that has been constructed, Fig. 36, delivers useful torque about 0.2 milliseconds after the application of the exciting voltage. An output torque of 21 oz-in. was obtained with 500 v excitation. However, the zero excitation drag was about 7.5 oz-in., an appreciable fraction of the engaged torque.

If resistance is present in the excitation circuit, the crystal voltage rises exponentially while the crystal is charged (crystal capacity is about 0.0065 mfd). Speed of response is related to this voltage rise. Because of nonlinearity in the crystal, there is an optimum value of series resistance that will give a firm response.

In the first clutch models, Rochelle salt crystals were used. However, this material is easily fractured, melts at 55 C and will absorb water unless protected from humidity. Barium titanate crystals are stronger mechanically and are usable at temperatures up to 100 C, although they have a lower sensitivity and a higher electrical capacity.

Loudspeaker Clutches

Another experimental development in the field of high speed servo clutches is the loudspeaker type clutch. This unit operates on the same principle as the electrodynamic loudspeaker of an ordinary radio receiver and is actuated by applying d-c to a coil located in a constant magnetic field, Fig. 37. The force resulting from the interaction of the coil current and the magnetic field moves the coil and causes the clutch output disk to be pressed against the rotating input members. In one model, full output-shaft torque of 10 oz-in. was attained in less than a third of a millisecond after the application of the actuating voltage. Possible applications include rapid starting and stopping of magnetic wire or tape recording media in high speed electronic computers and high speed switching in telephone dial systems.

The loudspeaker clutch is inherently capable of faster response than conventional electrical or magnetic friction clutches. In a conventional clutch, time as well as energy is required to build up a field after the actuating voltage is applied, while in the loudspeaker clutch, the necessary magnetic field is

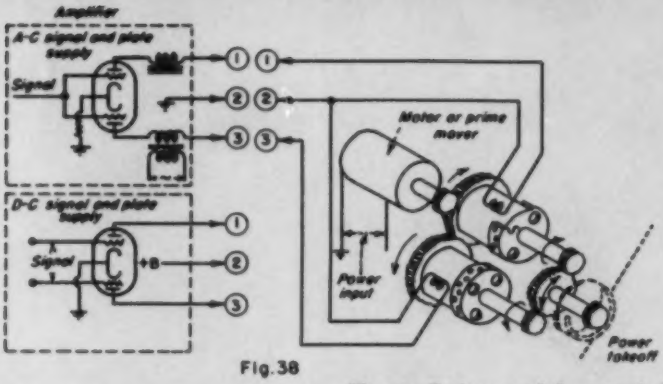


Fig. 38

Fig. 38—Basic a-c and d-c control circuitry for servo actuator incorporating two magnetic power clutches. These systems are available from Lear, Inc. Sensing circuits can be used to activate either of the two clutch circuits.

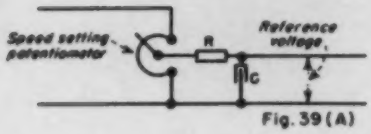


Fig. 39 (A)

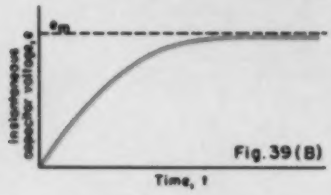


Fig. 39 (B)

Fig. 39—(left) (A) One circuit used by Dynamatic obtaining exponential control of acceleration in clutch speed control systems. Load velocity will vary with time in the same manner as capacity voltage varies with time, (B), after a sudden change in speed setting.

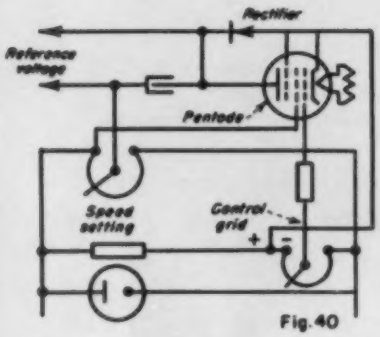


Fig. 40

Fig. 40 — Clutch control circuit used by Dynamatic to obtain linear control of acceleration. By using the pentode, a constant capacitor charging rate and consequently a linear acceleration can be achieved. Acceleration is adjusted by setting the control grid potential.

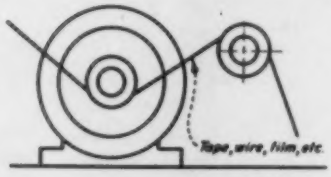


Fig. 41

Fig. 41 — Typical brake tensioning set-up as recommended by Magtrol. If instead of using this method, the unwinding reel is attached directly to the brake, the changing diameter of the roll is compensated for by having a follower roll actuate a variable resistor whose change of resistance with motion matches the slope of the torque — current curve of the brake.

already in existence before the clutch is actuated. The inductance of the moving coil is normally small and can be made negligible by means of compensating coils. Thus the time required for the coil current to build up to press the clutching surfaces together is equally negligible.

Clutch Applications and Control Circuits

The clutch excitation signal must be d-c to achieve high forces at a high efficiency. In ordinary single-ended control circuits, a full-wave rectifier bridge can be used to supply direct current. A capacitance-resistance filter is normally required for smoothing the clutch chatter caused by the a-c excitation current component. Where excitation is derived from a polarity sensitive a-c error detector, a combination of a phase sensitive detector and a d-c amplifier must be used.

The schematic of Fig. 38 shows two basic vacuum tube circuits for controlling the clutch excitation coils of an actuator using magnetic powder clutches. The addition of feedback, stabilizing means and a preamplifier enables the resulting control system to control a variety of functions.

The amplifier can incorporate features such as current feedback or high plate resistance pentodes that can force the clutch control current and compensate for the inherent coil time delay. Improvements in the time constant (and closed loop stability) by factors of 20 to 100 can be obtained by careful design. Where intermittent instead of linear clutch torques are developed, current forcing methods based on capacitor discharge through a thyratron can be used to increase the speed of response.

When high inertia loads must be accelerated or when processing equipment requires a smooth increase of driving torque, acceleration control can be used. Systems incorporating clutch control can be used in many of these applications including the manufacture of wire, paper, linoleum, plastics, rubber and other materials. Since acceleration rates can be closely matched, two or more drives can be started simultaneously.

When clutches are used for speed control by bucking a reference voltage against the output voltage of a load-coupled tachometer, controlled acceleration can be obtained by using the circuit shown in Fig. 39 (A). If there is a sudden change in the speed setting from zero, then the voltage across the capacitor can be expressed as

$$e = e_m(1 - \epsilon^{-t/RC})$$

where e = instantaneous voltage across capacitor
e_m = voltage corresponding to new speed setting
t = time
R = resistance
C = capacitance

If the servo loop can respond rapidly enough to accelerate as desired, the curve indicating the variation of velocity with time will follow the exponential relation representing the variation of capacitor voltage, e, with time, Fig. 39 (B). This exponential type of acceleration control, gives high accelerations for starting, with a logarithmic decrease in acceleration as the unit approaches the preset speed.

When logarithmic acceleration is desired and a longer time base is required than is possible with the circuit shown in Fig. 39 (A), a triode tube can be substituted for the resistor. By controlling the grid of the tube, the charging rate of the capacitor can be adjusted. Thus the circuit can be set for any desirable time base within practical limits.

A circuit that can be used to obtain linear acceleration is shown in Fig. 40.

With this arrangement a pentode tube is substituted for the fixed resistor. In addition to the basic tube elements of the cathode, plate and grid, a pentode contains a suppressor grid and screen grid. By keeping the screen grid at a constant positive voltage with respect to the cathode, the plate current is reduced to the function of control-grid voltage only, supplying a constant charging rate in spite of the leveling off of the plate-to-cathode voltage. Since the capacitor charging rate is constant, the voltage across it must increase linearly with time. The control grid voltage is adjustable so that the capacitor charging rate or load acceleration can be set as required. When the control is reset for a lower speed, the rectifier serves as a discharge path for the capacitor.

Another function of clutch systems is to protect against overload by limiting the transmitted torque. This function is required where heavy intermittent overloads occur during starting or operation. For example, processing equipment is subjected to occasional overloads because of the nonuniformity of feeding mechanisms, or because foreign objects are mixed in with the material being processed. Specific applications are conveyor drives, pulverizing mill drives and various machine tool drives.

One torque-limiting system uses main drive-motor current as an indication of transmitted torque, since this current is closely related to motor torque. A d-c voltage proportional to current regulates the grid of a tube. The tube plate current is supplied to a potentiometer. The setting of this potentiometer determines the speed control reference voltage. Heavy currents in the motor windings subject the control grid to a large negative bias, limiting the reference voltage and eventually forcing this voltage to assume a value of zero.

This reduces load coupling by reducing clutch excitation. As load speed is reduced, an equilibrium of limited torque is reached. Increased flexibility can be obtained by using potentiometers and resistor switching.

When used with a synchronous motor drive, torque limiting prevents the loss of synchronism because of transient overloads.

In typical designs, brakes and clutches are identical with the exception that simpler mechanical design is inherently possible in the brake and that slip rings are usually omitted. Fig. 41 shows a hysteresis brake used to maintain the desired value of tension in an unwinding reel.

A combination braking-clutching system for controlling tension is shown in Fig. 42. Power is applied in intermittent pulses as the sensing roll in the material take-off moves a switch arm to energize clutch or brake, depending on the tension requirements. When the motor starts, the clutch drives the reel until the tension is sufficient to break the clutch contact on the sensing arm. This interruption relieves the tension, restores clutch control and repeats the cycle, causing a perpetually hunting control, pulsating at a frequency above resonance.

In Fig. 43 is shown a clutch control system for controlling load speed. This system uses a water-cooled eddy current such as the one that is illustrated in Fig. 31. The eddy current clutch incorporates an a-c tachometer on the output shaft for feedback purposes. Fractional percent precision over a speed range of several hundred is feasible with this arrangement.

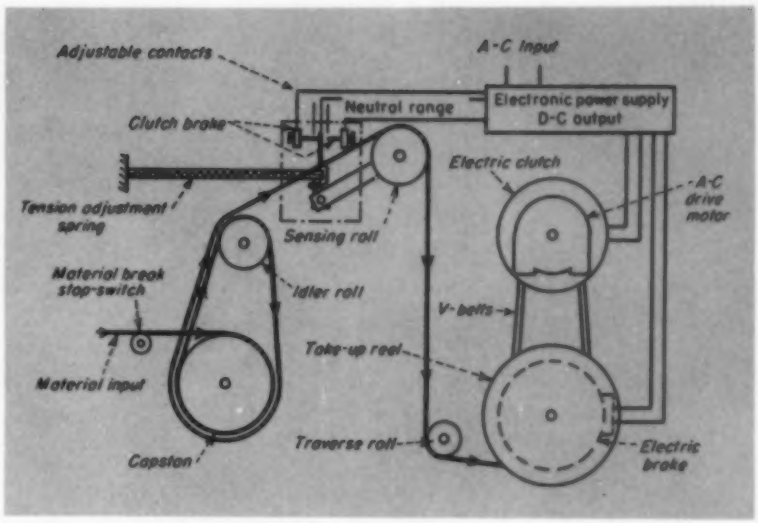


Fig. 42 — Intermittent power pulse control of brake — clutch system used for maintaining constant tension. System was designed by Warner Electric Brake and Clutch Co. The system continually hunts to maintain the proper tension.

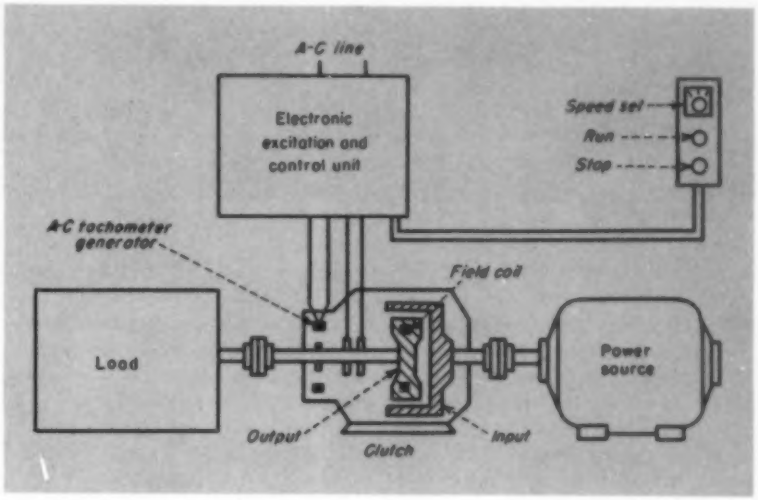


Fig. 43 — Dynamatic eddy-current clutch with feedback tachometer on the output shaft. Load speed can be adjusted by varying the speed-set device.

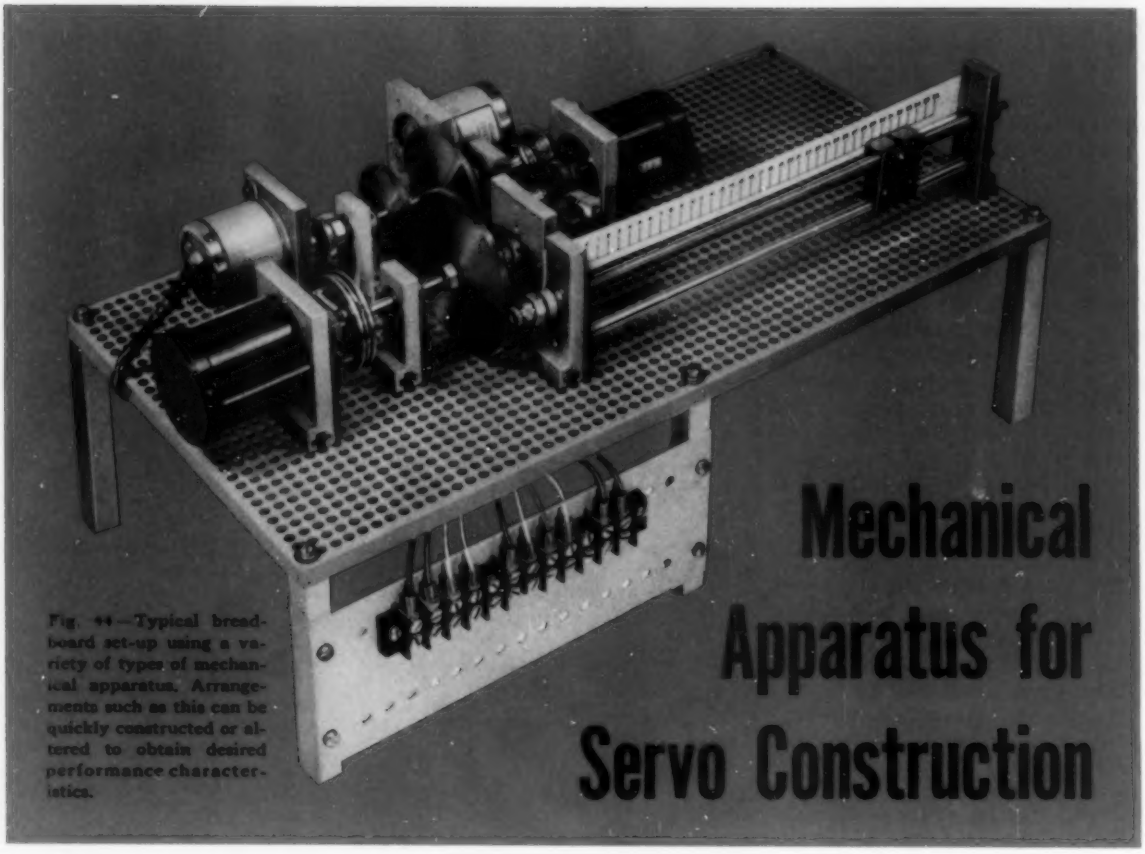


Fig. 44—Typical breadboard set-up using a variety of types of mechanical apparatus. Arrangements such as this can be quickly constructed or altered to obtain desired performance characteristics.

Mechanical Apparatus for Servo Construction

TO PERMIT THE RAPID ASSEMBLY of mechanical breadboards, or permanent or semi-permanent servo systems, an assortment of standardized precision-built components is available. All of these components are stock items with various manufacturers and include not only the usual servo hardware such as gear trains and differentials, but in addition a variety of general purpose adapters aimed at achieving maximum flexibility.

In Fig. 44 is shown a typical breadboard set-up incorporating many of these devices. The development of this line of components was made possible largely because various government agencies standardized on specific outlines and performance features for synchros, motors, tachometers and other rotating components common in automatic control systems. Of particular importance was the establishment of standard frames, mounting methods and shaft diameters.

While this mechanical hardware is still relatively expensive, it has been adopted by many organizations doing development work in control systems. Where educational institutions require flexibility and functional variety at minimum cost this equipment has found use. Although breadboards of these standard parts do not give the finished compact appearance of a specialized design, they have found application in finished equipment of such a specialized nature that final production-line designs are uneconomical.

By using breadboard arrangements, designs can be tested in mock-up form prior to the packaging of a final system. An engineer may save development time by working on a breadboard, adjusting parameters to achieve performance requirements and in some instances omitting altogether the paper design stage. By experimental manipulation, tolerances can be varied and producibility evaluated. The effects of nonlinearities such as backlash and resiliences in shafts, and the nature of transient shock loads and amplifier saturation can be observed beforehand and tolerances that are appropriate for production can be established.

Manufacturers of this apparatus are adding components (such as servo dampers and magnetic clutches) to their standard line with the view toward increasing versatility. To simplify stocking needs and to reduce the variety of devices that are of a different size or shape but perform the same function, various items have been standardized by the different manufacturers. These items include gear materials (which are usually limited to stainless steel and aluminum), shaft diameters (although adapters are available), height of component centerlines above baseboard, gear pitch and face widths. However, most manufacturers are willing to supply special purpose parts to order.

Accuracy

Mechanical breadboard apparatus must necessarily be precise since it is used in closed loop systems. The general purpose nature of the hardware does not imply inaccuracies or the com-

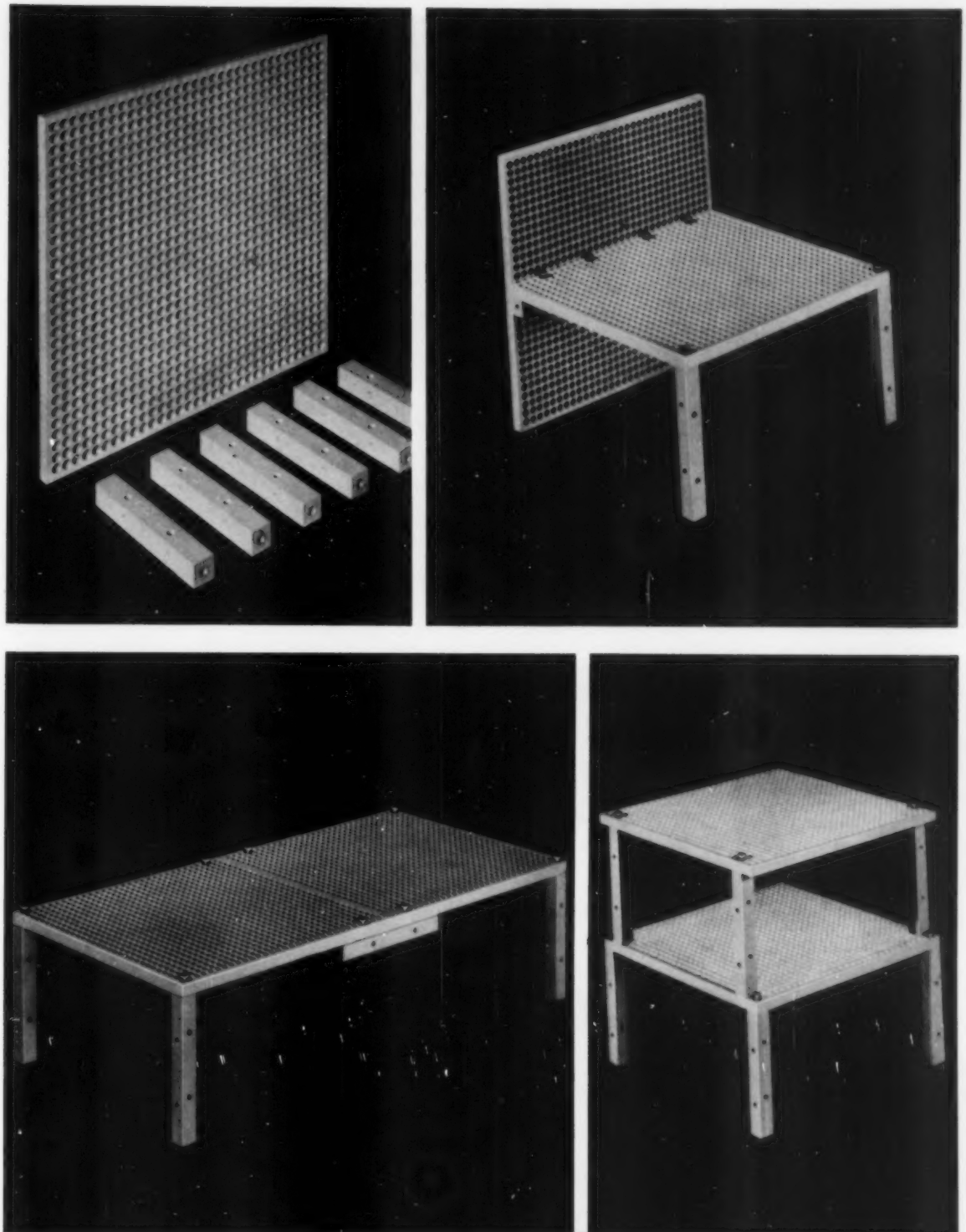


Fig. 45 – Base plates and fastening arrangements by Servomechanisms, Inc. The foundation or base plate, (A), can be slotted or drilled. The combination of holes in the plate together with the lateral freedom of movement that is possible in the mounting blocks gives continuous adjustability in the placement and alignment of components.

promise of performance in specific situations. Computing equipment of better than 0.1 percent accuracy can be synthesized using this apparatus.

The design of coupling devices is tricky, since angular shifts of a minute between coupled points may be enough to cause trouble. Similar care must be taken with clamping and zeroing devices. If required, gears are available having composite errors of 0.0002 in. Mounting plates must be rigid, and consideration must be given to the temperature coefficients of expansion of the various parts. However, since general purpose apparatus is not usually applied where extremes in packaging and miniaturization are required (such as in final military designs) wide temperature variations do not present a problem. The adjustability of the center distances permits accurate backlash regulation and results in good gear performance.

Variety of Component Parts

The following basic component parts are normally standard. Additional supplementary pieces such as special bolts, clamps and adapters are supplied with each. These supplementary pieces are made as universal as possible for use with different kinds of components. There is little difference among manufacturers in the variety of these basic components. However, some manufacturers offer special design features peculiar to their own product that can be used to advantage in a particular application.

Base plates — The basic mounting surface machined to permit the accurate alignment of the mechanical components.

Mounting hangers — Drilled to mount many rotating elements such as motors, synchros, potentiometers and bearings. Also available blank for special drilling.

Couplings — Available for various shaft diameters. Designed to be insensitive to small misalignments in applications requiring minimum backlash.

Gearing — Available in standard fine pitches. Materials are usually stainless steel and aluminum. Special low inertia gearing is also available.

Limit Stops — Mechanical or electromechanical motion limiting devices for applications such as in the drive of a limited rotation potentiometer.

Dial assemblies — Available with convenient dial markings, either standard or to order. Concentric dials are useful in multi-speed systems.

Terminal blocks — Centralized locations for electrically interconnecting electronic and electromechanical parts.

Crank — For the manual insertion of information into a system.

Clutches — Slip clutches for preventing transient overloads in conjunction with limit stops and magnetic clutches for dynamic control.

These various classifications of components as supplied by different manufacturers are illustrated in the following material.

The following illustrations also indicate the vast variety of basis components that can be supplied by the various manufacturers. The interchangeability or substitution of the components from one type of board installation to another is usually possible. In the following figures, only one company is mentioned in connection with any single type; however, the components are usually made by several of the companies with only small variation. Final results, in almost all instances, will be similar.

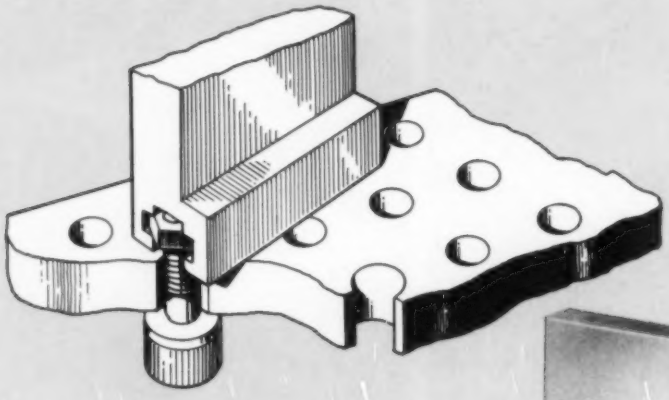


Fig. 45 — (B) (left) Captive nut in the slot of a mounting or bearing block. For position adjustment the block is free to move laterally, but can be securely anchored by tightening the screws.

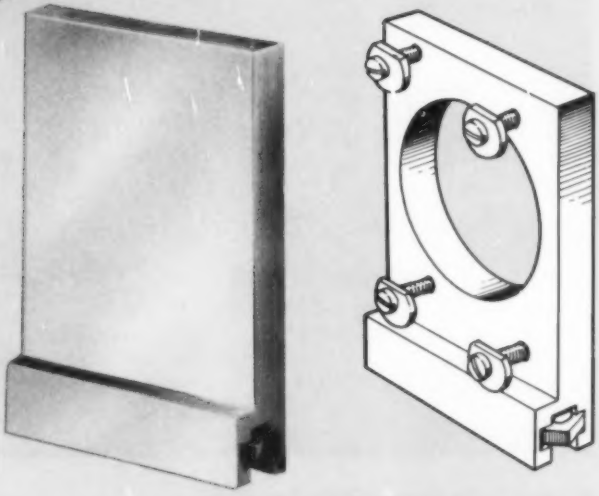


Fig. 46—(right) Mounting devices manufactured by Servomechanisms, Inc. (A) shows mounting blocks used to accurately support electrical components such as motors, synchros and potentiometers. The drilled blocks are used to mount standard components at a fixed distance above the base plate. The blank blocks are used when special devices must be mounted or when the centerline distance to the base

plate must be varied. Bearing blocks, (B) (right), are low-friction precision-aligned shaft supports for general use. Reeves Instrument supplies a model with adjustable eccentricity to permit the precise setting of gear train backlash.

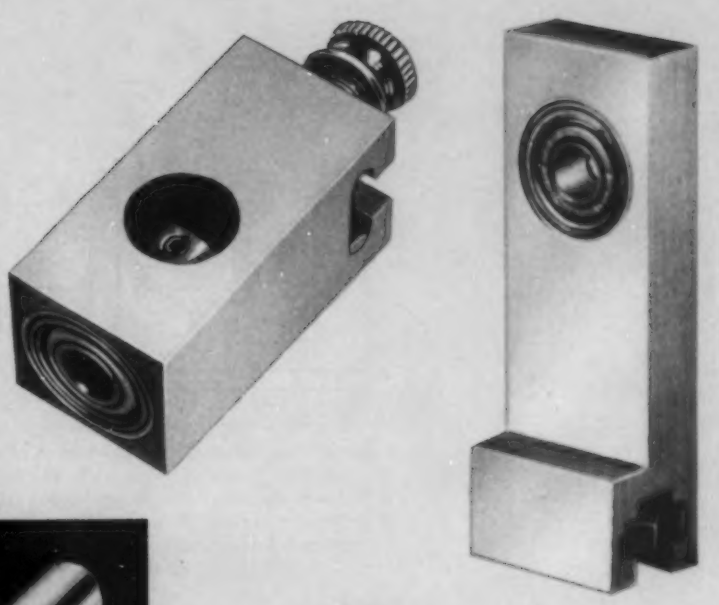


Fig. 47 – Typical shaft adapter assembly components including adapter, spacer and shaft stop. Unit has provision at one end for receiving and clamping a second shaft of the same or different diameter. The adapter cone and lock nut clamping method is used.

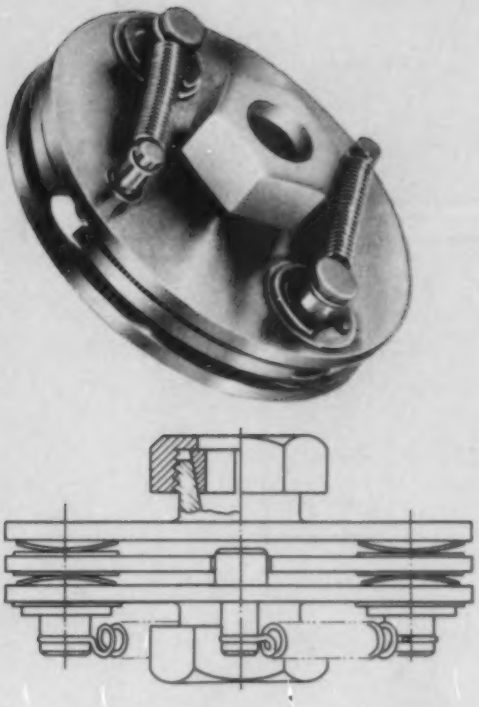
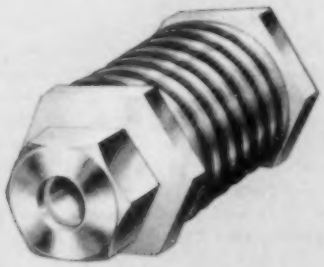


Fig. 48 – Shaft coupling devices by Servomechanisms, Inc. The standard Oldham coupling, (A) (above), is used for high-torque, medium-speed, zero-backlash operation. Slight angularity and shaft misalignment do not interfere with the operation of this component. The bellows coupling, (B) (left), is suitable for shaft coupling in low-torque applications. The bellows action permits a reasonable degree of angularity and misalignment.



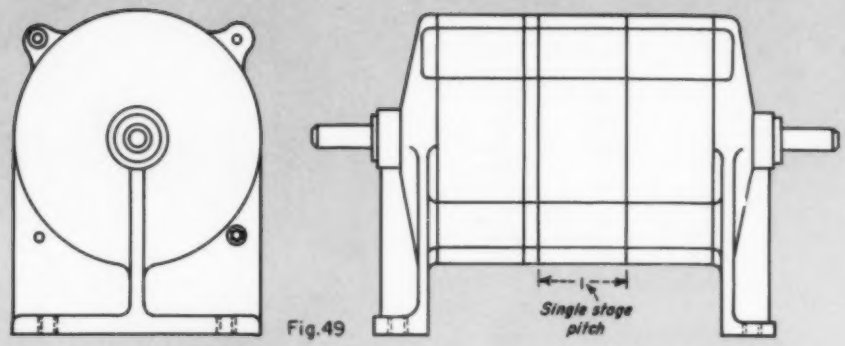


Fig. 49

Fig. 49 — The Belock Instrument Corp. has available a universal speed reducer kit that is suitable for achieving special gear ratios in a compact assembly. Unit consists of 5 gear sections with ratios of 2, 3, 4, 5 and 7 to 1, each with half of an Oldham coupling. Maximum torque is 10 ft-lbs with backlash under 0.002 in. per section, coupling included. By proper arrangement, many gear ratios can be obtained. For example, a ratio of 17.5 to 1 is obtained by using sections with ratios of 2, 5 and 7 to 1, which are assembled with the 2 to 1 section reversed.

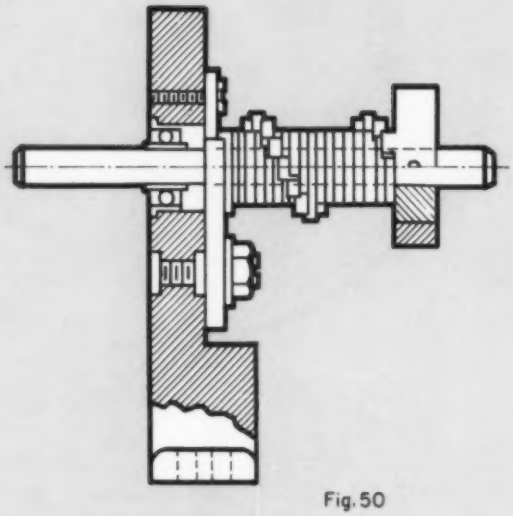


Fig. 50

To determine number of washers and size of upper limit stop:

$$N = \frac{T - 270 + U}{300}$$

Where: N = No. of washers required

T = Total travel of shaft in degrees

270 = No. of degrees rotation permitted by lower limit stop

U = No. of degrees rotation prevented by upper limit stop

300 = No. of degrees rotation permitted by each stop washer

The value of U is established by inspection and trial so that the value of the numerator, (T−270+U) is equal to a mutiple of 300 degrees.

This results in a value for N = a whole number of washers.

EXAMPLE: Find N & U to give T = 10 Turns

$T = 10 \times 360 = 3600$ deg.

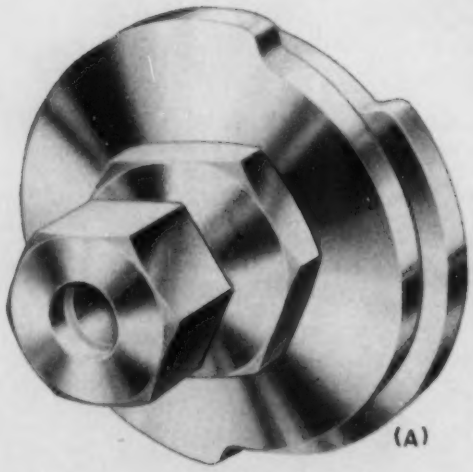
$$N = \frac{3600 - 270 + U}{300} = \frac{3330 + U}{300}$$

Let U = 270 deg.

$$N = \frac{333 - 270}{300} = \frac{3600}{300} = 12$$

Use 12 washers and upper limit stop with U = 270 degrees.

Fig. 50 — Reeves Instrument limit stop for restricting range of rotary motion. This unit will only withstand moderate loading. Adjustments can be made so that the allowable angular travel will match the desired range. For example, the limited motion of a multi-turn potentiometer. Angular motion is determined by the number of washers and the setting of the upper limit stop.



(A)

Fig. 51 — Actuating devices. Standard cam assembly, (A), is designed to be clamped to a shaft to actuate a device such as a Micro Switch. The time schedule can be varied by the relative adjustment of the two cams. The block and switch assembly, (B), can be actuated by the cam shown in (A). It is designed for those applications where an electrical circuit must be opened or closed at specific shaft rotational positions. Cam and switch assembly are manufactured by Servomechanisms, Inc.

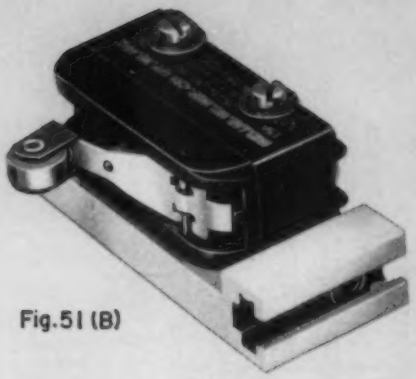


Fig. 51 (B)

Fig. 52 — Manual input hand crank by Belock Instrument. This unit is used for the manual introduction of data in a computer, for pre-setting gear trains and for other similar operations.

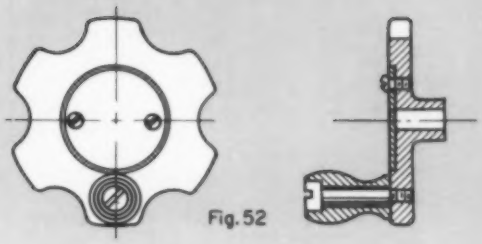


Fig. 52

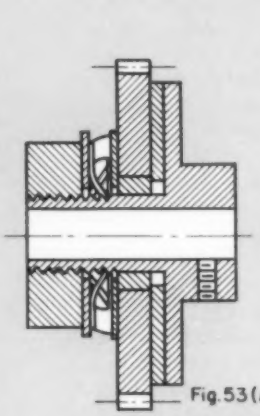


Fig. 53 (A)

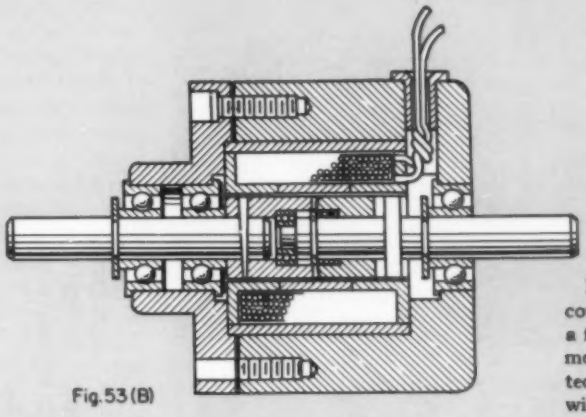


Fig. 53 (B)

Fig. 53 — Slip and regulating clutches. The Reeves Instrument adjustable slip clutch, (A) (left), is used for limiting peak mechanical loads. Within limited ranges it can be adjusted by varying the spring tension. The magnetic clutch shown in (B) (right), is similar to those discussed in the section on clutches. It can be used in small clutch type control systems or for the remote coupling of elements in a complex mechanical assembly. The unit is of the crown-tooth type.

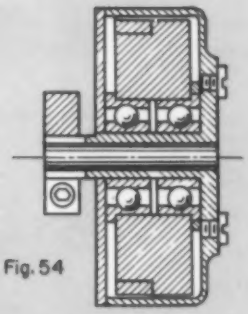


Fig. 54

Fig. 54 — The Reeves Instrument viscous inertia damper effectively couples a flywheel to a servo shaft through the medium of a viscous silicone fluid. This technique gives satisfactory damping with extremely high velocity constants. Units such as this are available as independent elements to be coupled into a servo system.

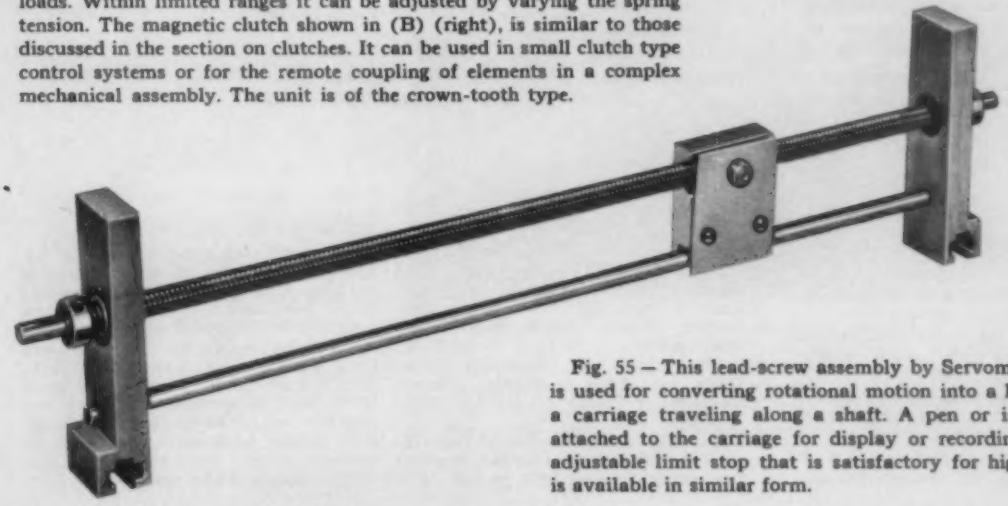
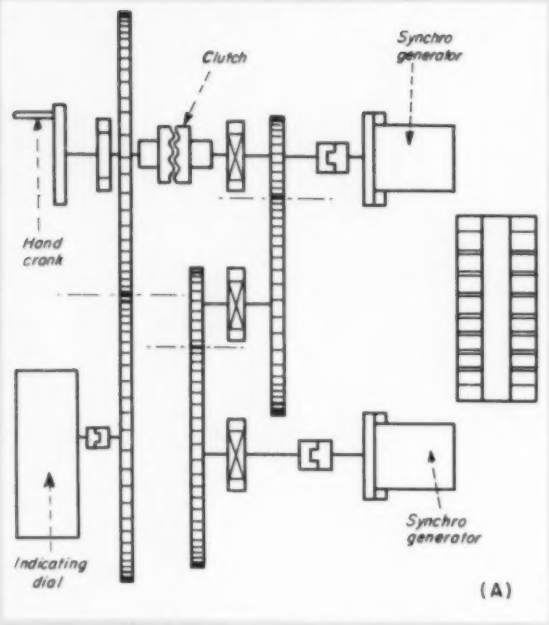
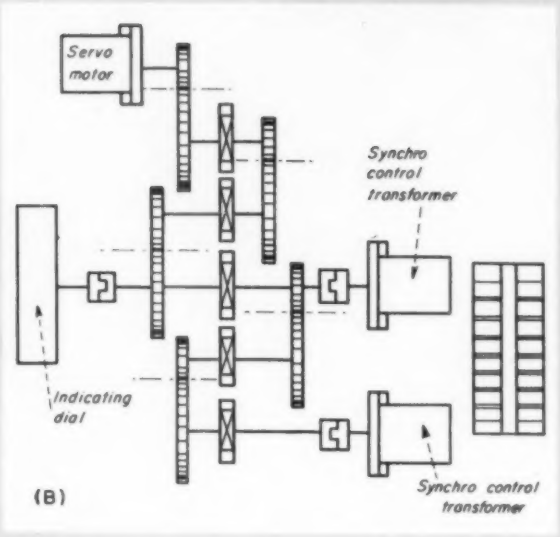
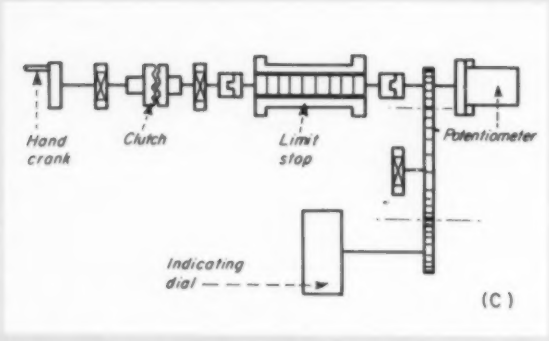


Fig. 55 — This lead-screw assembly by Servomechanisms, Inc., is used for converting rotational motion into a linear motion of a carriage traveling along a shaft. A pen or indicator can be attached to the carriage for display or recording purposes. An adjustable limit stop that is satisfactory for high impact loads is available in similar form.







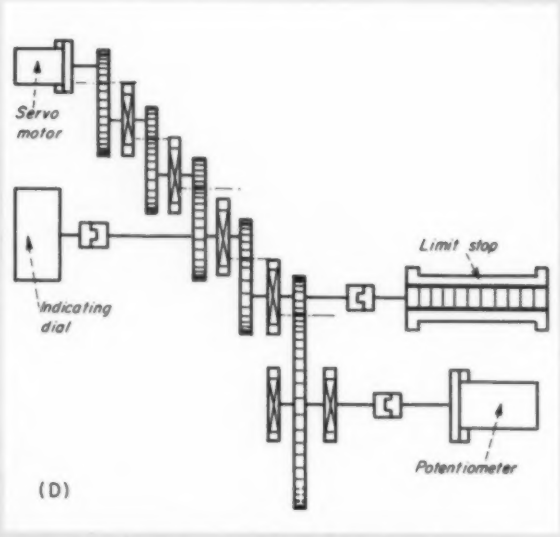


Fig. 56 – These schematic diagrams represent typical assemblies that can be constructed using Belock standard mechanical parts. A variety of arrangements is possible with a minimum number of different components. (A) (above, left), represents a multi-speed synchro transmitter, (B) (above, right), a multi-speed synchro receiver. (C) (above), a potentiometer transmitter and (D) (right), a potentiometer receiver.

SELECTED REFERENCES

1. Nathaniel B. Nichols, Backlash in a Velocity Lag Servomechanism, AIEE *Applications and Industry*, January 1954.
2. Stuelpnagel and Dallas, Off-On Modulated Reversing Clutch Servo, AIEE *Applications and Industry*, January 1953.
3. *Instrument Servomechanisms*, NAVEXOS, Special Devices Center, Office of Naval Research, U. S. NAVY.
4. H. M. James, N. B. Nichols and R. S. Phillips, Theory of Servomechanisms, *McGraw-Hill Book Co.*, New York, N. Y., 1947
5. Abraham M. Fuchs, Motor and Gear Train Selection for Automatic Control Systems, *Product Engineering*, March 1953, pp 128
6. E. G. Burgess, Jr., Designing Gear Trains for Minimum Inertia, *Annual Handbook of Product Design for 1954*, pp E 14
7. A. H. Decker, Modern Control Circuits for Electric Brakes and Clutches, *Product Engineering*, February 1952, pp 138

ACKNOWLEDGEMENTS:

The author would like to thank the following concerns who supplied technical data and illustrations for this article: Arma Corp.; Belock Instrument Corp.; Bowmar Instrument Corp.; Clark Manufacturing Co.; Duncan and Bayley Div. of General Riveters, Inc.; Dynamatic Corp.; Eastern Air Devices, Inc.; Ford Instrument Co. Div. of the Sperry Corp.; Lear, Incorporated; Librascope, Inc.; Magtrol, Inc.; National Bureau of Standards; Norden Instruments Inc.; Reeves Instrument Corp.; Servomechanisms, Inc.; Warner Electric Brake & Clutch Co.

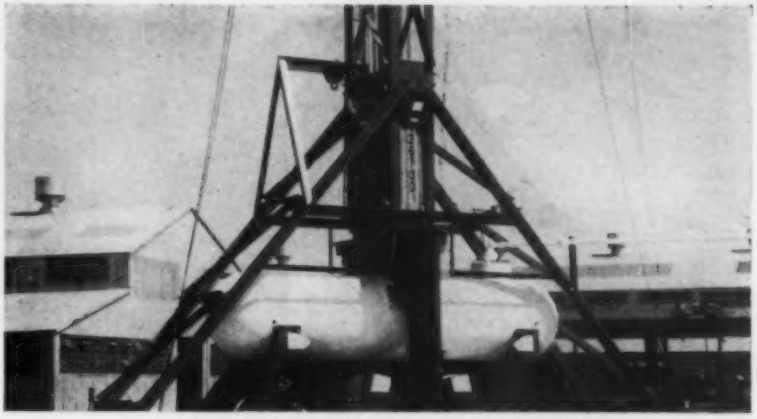
Operation Destruction

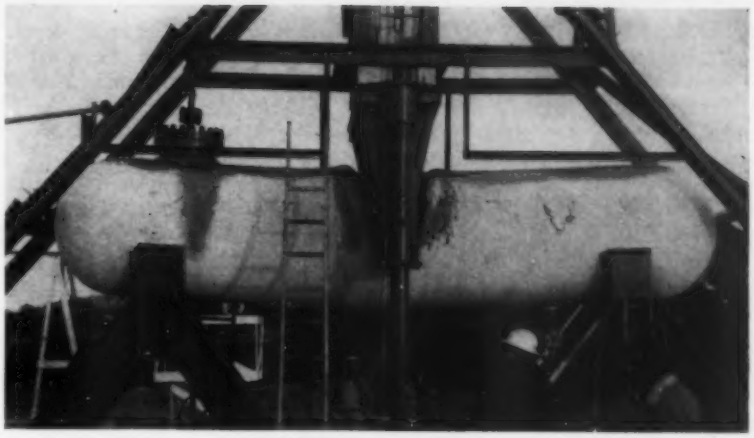
FOR THE PAST FEW YEARS U. S. Steel has been using a quenched and tempered alloy plate steel called Carilloy T-1 rather successfully in a variety of applications—particularly on heavy earth moving and mining equipment. Because this steel has a high yield strength (90,000 psi, 0.2 per cent offset), and good toughness at low temperatures, U. S. Steel thought that it could be used to advantage in pressure vessels. However, the only catch here is that the ASME Boiler Code and other regulating agencies do not allow quenched and tempered steels.

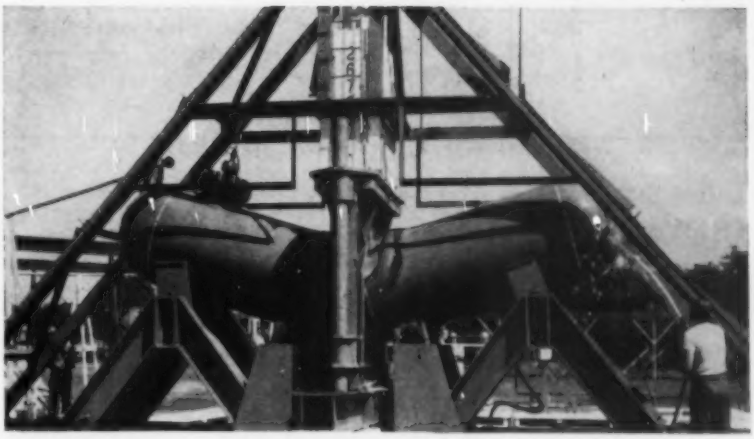
With this in mind, U. S. Steel, at the Birmingham plant of the Chicago Bridge & Iron Co., carried out destructive tests on eight full-sized vessels to demonstrate to these various agencies the: (1) advantages of using quenched and tempered steel instead of the conventional carbon steels for pressure vessels, particularly those operating at low temperatures; and (2) the suitability of modifying the present requirements for stress relieving.

The test consisted of: (1) a burst test at a temperature of about —45 F of an unstressed relieved pressure vessel made from T-1 steel; (2) a burst test of a vessel similar to (1) except that it was stress relieved; (3) a drop test of an unstressed relieved pressure vessel (also Carilloy T-1); (4) test similar to (3) except vessel was stress relieved.

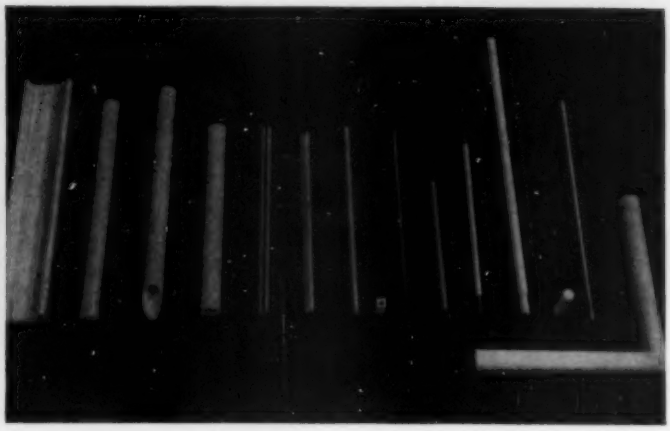
U. S. Steel claims that by using T-1 (1) for the same pressure and thickness the radius may be increased in direct proportion to the ratio of the working stresses; (2) for the same radius and thickness the pressure may be increased in direct proportion to the ratio of the working stresses; (3) for the same pressure and radius the thickness may be decreased in inverse proportion to the ratio of the working stresses; (4) the reduction in thickness increases the range of the vessel sizes or pressures that may be fabricated without stress relief.







AT TOP, the drop test vessel is in position and refrigerated to —45 F with an internal pressure of about 1875 psi maintained. A 26,700 lb weight will hit it from a distance of 52, 73, and 101 feet. The 52 ft drop only knocks the frost off the vessel. The 73 ft drop (center) beats the saddles into the vessel giving it a permanent set of about 2 in., but there is no rupture. The 101 ft drop (bottom) causes the vessel to part in the center. The weight has hit the tank with an impact energy of 2,790,000 ft-pounds.



R-F Curing Speeds Reinforced Plastics Extrusions

PRODUCING STRUCTURAL SHAPES by a continuous method is making fiberglass reinforced plastic generally competitive (cost and usage) with aluminum extrusions. While extruded plastics parts are not exactly new, the key to a new process called glastruding, is the continuous curing by radio frequency of the plastic part before it comes out of the forming die, above. Result is a stepped up production rate. Owner of the new process is Glastrusions, Inc. who build machines for lease besides producing reinforced plastic tube, bar, angle, channel, and other shapes.

The process is this: Ends of a given number of fibrous glass rovings are stacked and passed through a dip tank where they are impregnated with a liquid polyester resin mixture. The ends are then threaded through a plastic die of the size and shape of the part to be produced. As the material passes through this bushing, heat by r-f cures it into a solid piece. It is then drawn out fully cured and cut into desired lengths.

The model 400 machine is equipped with a rack arrangement to hold the 240-end glass fiber packages. The rovings are stored in cake form, but when required, woven or other cross-fibered glass material can be used on the same machine. At present the stock is made of parallel fibers. The number of ends of fiberglass used is determined by the size of the stock to be made and the percentage of the glass required.

The resins, pigments, fillers, catalysts, or dyes are mixed then poured in liquid form into the resin pan as needed to keep the operation continuous. Where toughness rather than rigidity is required, a blend of a flexible with a rigid resin is used, but no plasticizers as such are used.

In tubing, wall thicknesses have been as small as 0.030 inch. Structural tubing up to 3 in. in dia. has been made, and "I" beams $3\frac{1}{2}$ x $2\frac{1}{2}$ in. for ladder stock are now being made. On parts of small cross-sectional area, several pieces can be made simultaneously at the rate of 2 to 10 feet per minute.

Approximate properties of glastruded parts (they vary with fibers, resins, fillers, etc.) are: Tensile strength, 100,000 to 144,000 psi; Modulus of elasticity 5.3 x 10^6; Compressive strength, 40,000 psi; Flexural strength, 64,000 psi; Rockwell M hardness 112; Specific gravity 1.85; Water absorption, 0.108 percent.

Latest Data on Cast Stainless Alloys

WINDING UP A PROJECT begun ten years ago, The Alloy Casting Institute, a technical association of high alloy foundries, has just released a compilation of a set of data sheets covering the properties of all the more popular grades of alloys used for corrosion resistant castings. The objective has been to present information of practical value to casting users regarding the properties of commercial material.

Accordingly, the mechanical properties given in the data sheets are considered to be representative of what may be expected from good commercial production. As the values do not represent the minimum side of the acceptable strength ranges, they should not be used for specification purposes; however, they do provide a useful base for the selection of design stress limits.

In most cases the mechanical properties have been determined from commercially produced heats rather than small, controlled laboratory melts. But, the lists of physical constants are based mainly on laboratory prepared material. Because only the results from wrought material were available for some alloys, part of the research program of ACI has been devoted to the study of the effect of variations in chemistry on the physical and mechanical properties of these alloys.

Besides listing the chemical compositions, physical and mechanical properties, the data sheets include a discussion of the design considerations. Each alloy is described with respect to metallurgical structure, and characteristics, with preferred heat treatments recommended. The general industrial fields of application are listed, together with the various corrosive in which each grade is successfully used.

AEC and North American To Build Sodium-Graphite Reactor

THE FIRST SODIUM-GRAPHITE REACTOR in the United States will be developed and constructed in a project that is being sponsored jointly by the Atomic Energy Commission and the North American Aviation, Inc. Estimated cost is $10-million, with North American paying ¼ of the total cost.

The sodium-graphite reactor is one of five types being considered by the AEC in its 5-year program for the development of economic nuclear power. Another type is the pressurized water reactor which will be used in the power plant being built for the AEC and The Duquesne Light Co. The other reactor types are: The homogeneous; the fast breeder; and the experimental boiling water reactors.

Characteristics of sodium which make it suitable as a reactor coolant are low neutron absorption qualities, good heat transfer properties, low melting point, and high boiling point. With sodium it is possible to get high temperature without high pressure.

New High Temperature Ceramic Coating

SEARCHING FOR ceramic coatings that can be used in high temperature nuclear reactors, some National Bureau of Standards scientists have come up with a promising formula which combines a high barium frit with a refractory of cerium or cerium-chromium oxides. This coating, usable at temperature up to 1,000 C, does not greatly absorb neutrons, unlike normal ceramics which can not be used in such applications because they capture a great number of neutrons.

While the overall project, of which these experiments are a part, is classified, it is known that one of the limiting factors in the design of an atomic aircraft power plant has been with materials. Metals which are suitably low in neutron capture cross sections often corrode at high temperatures. Low neutron cross-section ceramics may be the answer to the problem.

NBS scientists tested over 200 coatings made with low neutron capturing material. Of these, 16 looked promising on extended heating tests. Using one mil coatings: 5 gave "appreciable" protection to 321 Stainless; 10 gave "good" results on 309 steel; and 14 gave good results in 310 steel. All worked well on inconel and similar alloys with low coefficients of expansion.

In thermal shock tests, the best coatings withstood quenching in water at room temperature from 2,000 F.

One of the best frits evaluated (NBS no. 435) was about half SiO_2, ¼ BaO, 6 percent CaO, 5 percent ZnO, 10 percent BeO and 2 percent P_2O_5.

Shakers Are Getting Bigger

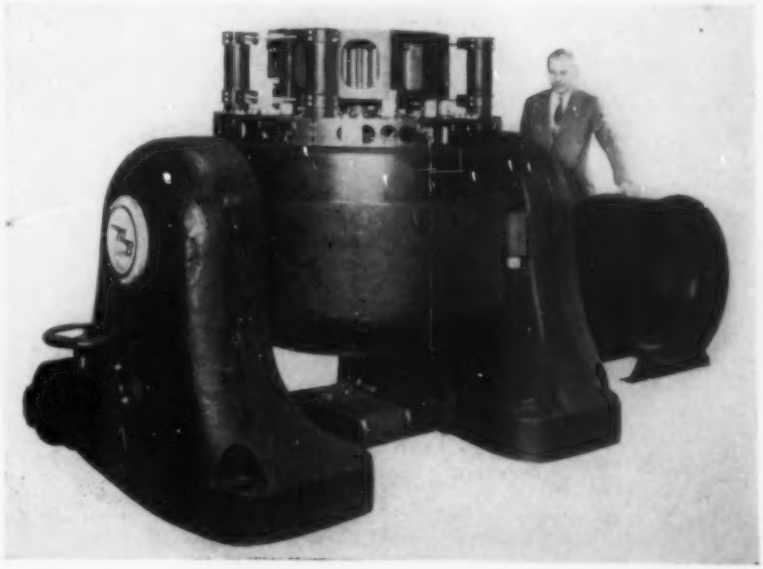
VIBRATION EXCITERS for shake testing of large structures and assemblies have been increasing in size, with the latest one by the MB Manufacturing Co., Inc., having a rated force output of 12,500 lb, continuous duty. The largest of its kind, the new model C-100 can produce accelerations of 10 G's at frequencies from 5 to 2,000 cps with test objects the size of automobile and truck chassis, guided missiles, and aircraft assemblies weighing up to 1,000 lb.

Like most of MB's smaller shakers, the C-100 is an electromagnetic force generator—the motion coming from an a-c carrying coil placed in a magnetic field. The moving element is this a-c driver coil connected to the table on which the test specimens are mounted. This entire unit, then, is attached to the exciter body by double cantilever spring flexures. The magnetic field is supplied by a d-c coil using the exciter body as a path for the magnetic flux. Table displacement, which is a maximum stroke of ½ in. (±¼ in.), and frequency can be set and maintained for a specified time.

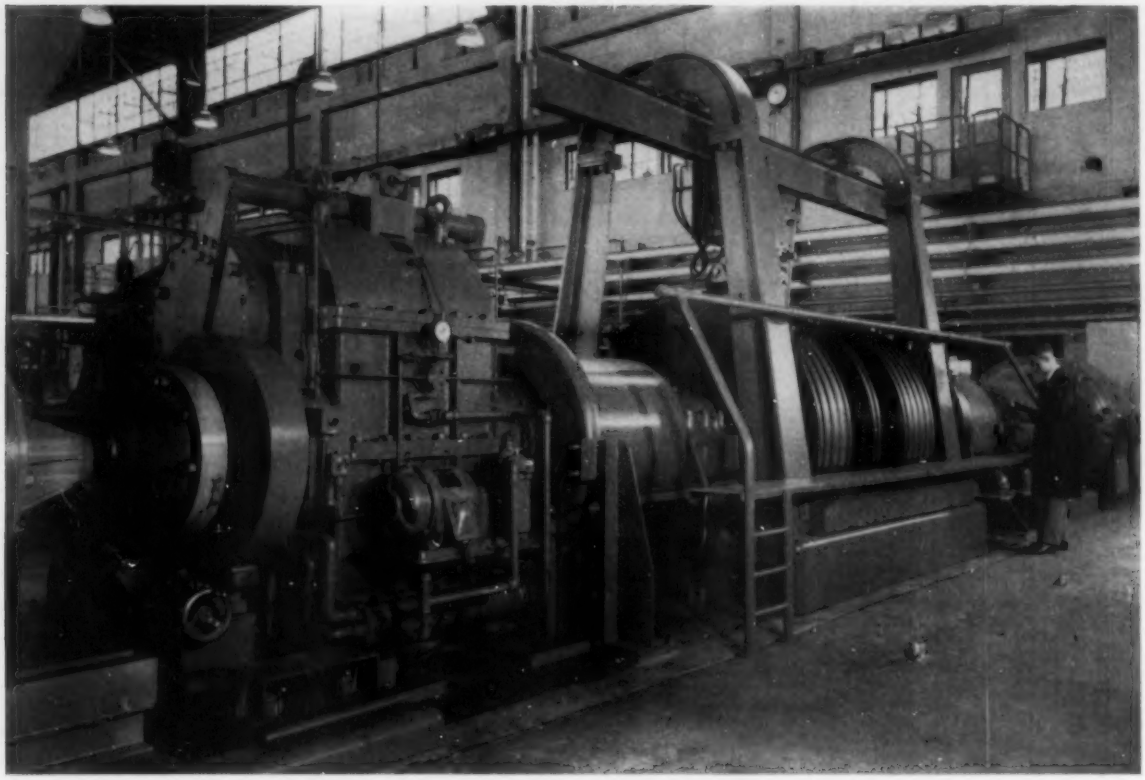
To keep the fundamental resonant modes of the moving element well above the operating frequency range and thus get the pure sinosoidal table motion, a high stiffness-to-weight ratio was necessary to prevent distortion of the table motion.

MB engineers achieved this with a deep-webbed magnesium casting for the table. This gave the size necessary to accommodate large test specimens, yet was able to meet all strength and weight requirements. Also, the base casting serves as a duct for cooling air supplied by the fan at right. The trunnion support has a non-reversing worm wheel drive at left to rotate the exciter into any position from vertical to horizontal.

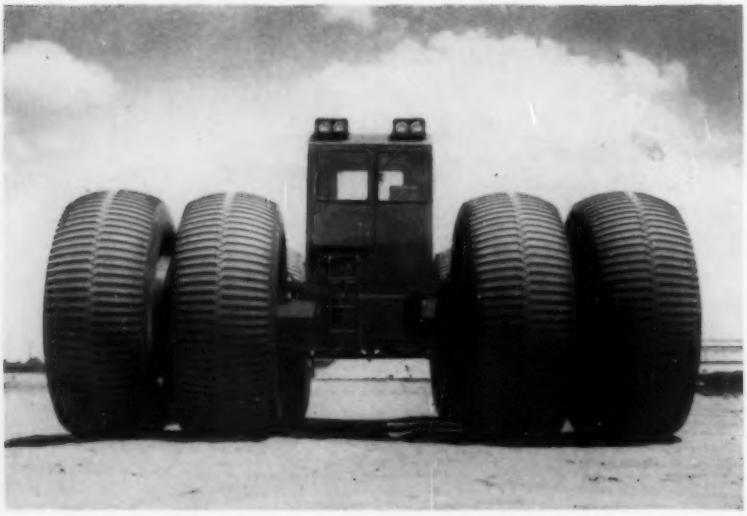
Previous to this unit, the largest exciter had only 3,500 lb. force. But MB is not stopping here—a 25,000 lb exciter is being developed and a 50,000 lb unit is contemplated.



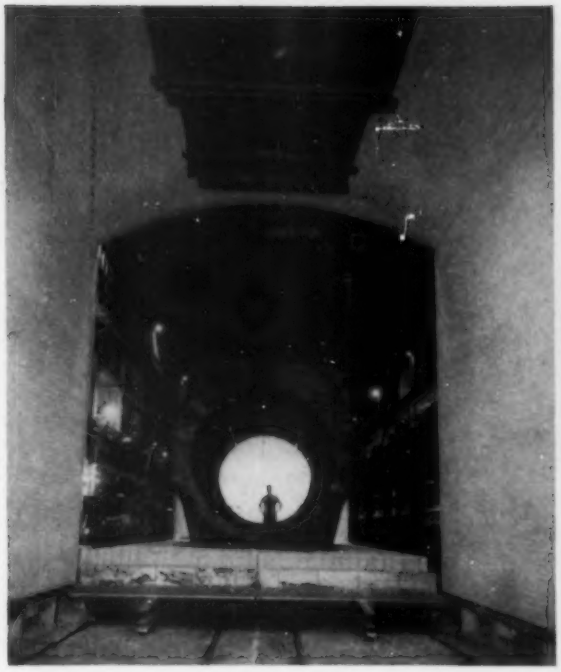
THE NEWS IN PICTURES



LARGE FLYWHEEL DISKS, 16 in all and weighing 27 tons, are shown on the new inertia-type dynamometer used for testing friction brake material at the Johns-Manville Research Center. The removable disks can be arranged for an inertia loading of 150 slug ft. sq. up to 6750 slug ft. sq. by increments of 50 slug ft. square. Flywheel bearings are lubricated by the oil ring, hydrostatic lift, and hydraulic pressure methods. The largest dynamometer of its kind, brake assemblies up to 60 in. in dia. can be tested.



MOUNTED ON the largest tires ever made, is R. G. LeTourneau's Sno-Buggy, a strange looking 8-wheeled vehicle designed to explore the arctic, desert, and swamplands. The Firestone tires, each 10 ft. in dia. and 4 ft. wide are mounted on aluminum rimmed wheels having their own built-in electric drive motor and gearing system, simplifying the design of equipment with all-wheel drive and steering. Overall width of the Sno-Buggy is 24 ft.; length, 27½ ft.; weight, 23 tons. Power is by a 400 hp engine and generator. Ground clearance is 3½ feet.

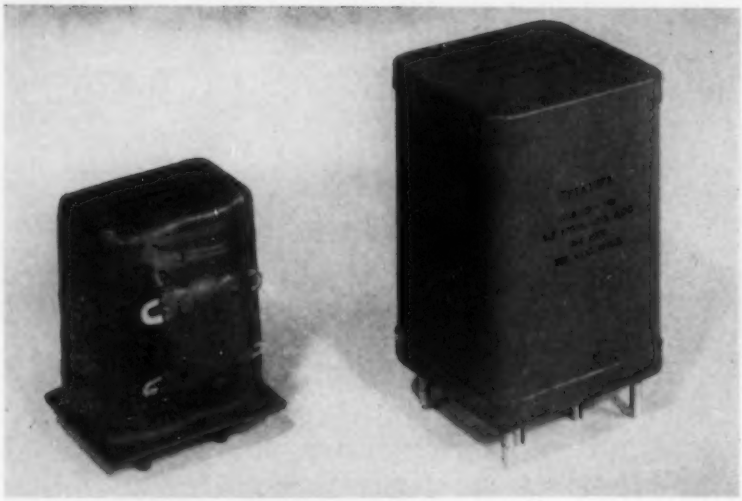


JUST INSTALLED at Westinghouse's East Pittsburgh, Pa. works, this huge, single chamber heat treating furnace is being used for stress relieving large weldments. The fully usable charge space measures 30 ft. long, 18 ft. wide, and 16 ft. high, with single or multiple parts weighing up to 100 tons being treated at one time. Maximum operating temperature is 1600 F. The front door, as well as the floor, rides on 20 car wheels on four railroad type tracks.

HIGH VELOCITY WATER flowing through a plastic bladed nozzle is used at General Motors new Technical Center to study the effects of turbine blade shapes and settings for possible use in automobile torque converters. The transparent nozzle permits visual checks and the use of high speed photography allows the engineers to analyze various blade shapes and angles under actual flow conditions.

COLOR PHOTOGRAPHY is coming to the aid of the manufacturers of complex electronic components, with a consequent reduction in production time and error. The assembler here at Bell Aircraft Corp. is working directly from a color transparency of the finished product, as opposed to the old method of working from blueprints, schematic diagrams, or prototype models. The new process is called Ecktacolor.

THE NAVAL ORDNANCE LABORATORY'S new reinforced plastic called Laminol (left), is compared with the earlier material. Not apparent here are the significant improvements to various properties of reinforced plastics realized from Chlorosilane finishes used on the glass fabric before impregnating with resin. These include: short time flexural strength and stiffness, both wet and dry; resilience, wet and dry; adhesive bonding strength; and creep resistance.



THE SAME MILITARY TRANSFORMER sealed in the new neoprene capsule left, and in the conventional can, right. While offering savings in weight, space, and cost, it still meets all the performance requirements of MIL-T-27, grade 1.

Now—Neoprene Protective Coatings

NEOPRENE ENCAPSULATIONS are now proving a match for the tin can no matter how severe the conditions. According to E. I. du Pont de Nemours & Co., open transformers up to 5kva, like those shown here made by the Aircraft Transformer Corp., are now being made which exceed the performance requirements of MIL-T-27, grade 1. Du Pont figures that by using a material based on their neoprene synthetic rubber, transformers, particularly those used in aircraft, can be encapsulated with a 30 to 40 per cent saving in space and weight, and a 15 to 25 per cent saving in cost, as compared to the conventional methods of sealing with a tin can.

A feature of the neoprene material is that it does not become brittle, even at low temperatures—a fault associated with most of the resins used for encapsulation purposes. Also, the terminals can be sealed by positive pressure; and nowhere does the seal depend upon adhesion of the capsule to metal. For instance, a typical terminal seal is a short neoprene sleeve pressed tight against the lead wire by a crimped metal ferrule. Then the mounting fixture is put on and the unit is dipped twice in a viscous neoprene compound.

One of the requirements of the MIL-T-27 specification is an insulation resistance greater than 1,000 megohms after 10 humidity cycles. Figures indicate that with the neoprene coating, units exceed 1,000 megohms after 100 cycles, and the 10-cycle insulation resistance is over 50,000 megohms.

Selenium rectifiers have been coated experimentally with promising results, with resistors, solenoids, and various sub-assemblies the next prospects.

Defense Research Management Criticized

AFTER SOME FIVE MONTHS of investigation, the House Government Operations committee's watchdog group reported that ". . . . . An alarming number of top creative scientists were leaving government service." In contrast, the group found an "apparent self-satisfaction" among top defense officials that the turnover does not exceed that of private industry.

The 72-page report, following such government-science controversies as the Oppenheimer case, has been regarded by some Washington research administrators as good ammunition which top civilian officials in the defense department can use to gain effective control of their military research program.

The committee, headed by Rep. R. Walter Riehlman, R., N. Y., said that ". . . . The problems, while they have not as yet impaired the research programs, pose a potential threat to U. S. scientific and technological progress."

The committee received testimony from 5 top Defense Department officials, 11 present and former research installation employees, and 5 witnesses for the general scientific community. Fifty other administrators and scientists made their views known by letter.

On the basis of this testimony, plus the staff investigations, the committee made these main recommendations:

(1) Civilian technical directors at research installations should be assigned specific authority and responsibility for technical direction. Military "rule by command" is inconsistent with "maximum achievement in the military research and development programs."

(2) The Government should contract out much of the research work now being done in its own laboratories. In addition, no "in house" research should be carried on just to train military officers.

(3) A program of basic research should be started and financed directly by the office of the Secretary of Defense. Such a program should include projects not directly applicable to immediate needs; and should supplement the work of the National Science Foundation.

(4) Unless high military officers show that they are willing to give civilian scientists a greater voice in top policy councils, Congress might consider setting up a civilian agency comparable to the World War II Office of Scientific Research and Development. Such an agency would be given responsibility for defense research. It does not, however, make such a recommendation now.

While the controversial issue of security clearance procedures was not a primary question that the subcommittee planned to discuss, it did specifically call to the attention of Military Departments the testimony on the subject it received from such witnesses as James Killian, MIT President, and John Von Neumann, of the Princeton, N. J., Institute for Advanced Study.

New Wrought Aluminum Alloy Designation System Announced

OFFICIALLY APPROVED by The Aluminum Association at its 1954 summer meeting, the new Alloy Designation System for Wrought Aluminum will go into effect October 1, 1954.

Consisting of four-digit numbers, the new system is expected to meet all of the industry's present and future needs for wrought alloys. The first digit of each designation indicates the general group to which a given alloy belongs. The last two digits identify the alloy or indicate the aluminum purity. The second digit indicates any modifications of the original alloy or impurity limits. To help the transition to the new system, many of the old numbers are retained as the last two digits of the new numbers. Thus, alloy 3S becomes 3003; alloy 24S becomes 2024; and 61S becomes 6061.

The general grouping of alloys under the new system is as follows: The 1xxx series designates minimum aluminum purities of 99.00 percent and higher. The last two digits indicate the minimum aluminum percentage. These digits are same as the two digits to the right of the decimal point in the minimum aluminum percentage when it is expressed to the nearest 0.01 percent. The second digit shows any modification in the impurity limits. The 2xxx through 8xxx series designates groups of alloys in which the following are major alloying elements: copper 2xxx; manganese 3xxx; silicon 4xxx; magnesium 5xxx; magnesium and silicon 6xxx; zinc 7xxx. The 8xxx series is used for alloying elements other than the foregoing, and the 9xxx series is unused at present, but allows for new designations.

A copy of the new designation system may be obtained from The Aluminum Association, 420 Lexington Ave., New York 17, N. Y.

A New Magazine For An Expanding Field

SEPTEMBER 1954 marks the beginning of *Control Engineering*, and a publishing venture deemed necessary for some time. For it was in 1944 that McGraw-Hill editors first thought of a magazine that would serve the instrument and automatic control industry.

A pilot issue of *Control Engineering*, prepared and edited by members of the editorial staff of *Product Engineering*, was published in January of this year. The response was so enthusiastic, that McGraw-Hill decided to publish it on a monthly basis hereafter. As of the first issue, paid circulation, which is strictly limited to instrument and control engineers and technically trained management in the industries that *Control Engineering* will serve, exceeds 16,000.

The editorial content will be: General Control and Instrumentation Systems; Specific Control and Instrumentation Systems; System and Design Analysis; Components; Component Design; Testing and Measuring Equipment; Reliability and Safety Features; and General Interest type articles.

News Briefs

NEARING COMPLETION at the Univ. of Wisconsin is a new general purpose, large-scale electronic digital computer, said to solve in a day problems requiring months by other means. Chief purpose of the project is to train young engineers in this rapidly growing field. One of the differences of the new computer is the use of integral synchronization. In one revolution the magnetic drum: looks up the instructions; looks up the two numbers involved; performs the arithmetic called for; and delivers the result. Other computers of this type required 4 revolutions. Another feature is a "floating decimal point" during operation. This usually must be "programmed in" most machines.

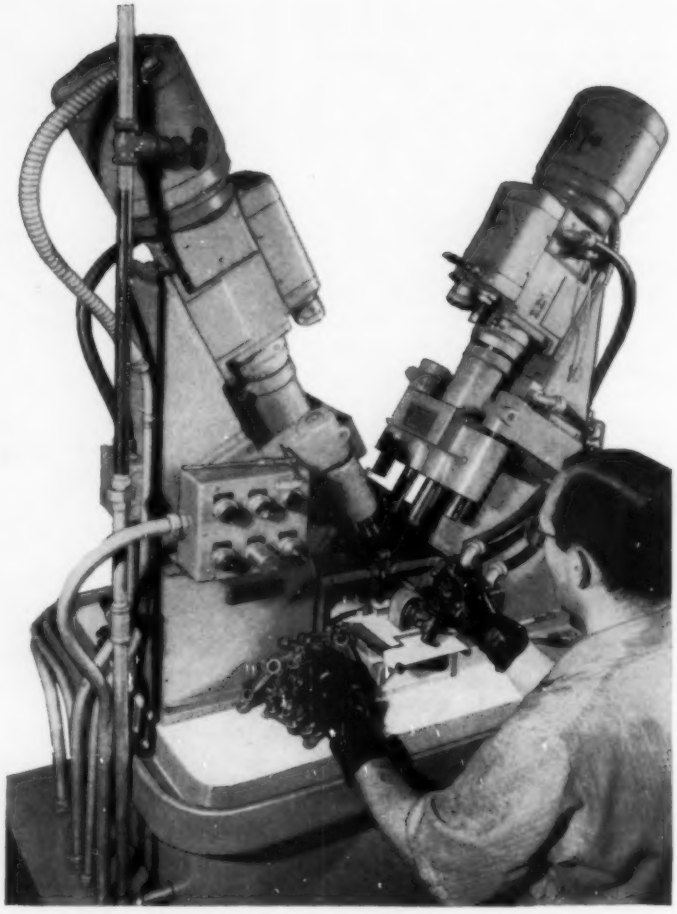
THE GENERAL ELECTRIC CO. has announced the development of an X-ray microscope that "looks inside" magnified specimens. The new instrument magnifies up to 1,500 diameters, and is expected to have wide use in medical science, industry, and biology. In the study of alloys, plastics, and composition rubber, the X-ray microscope shows the mixture of materials and can identify them by their relative X-ray absorbine power.

THE ALUMINUM CO. OF CANADA, LTD. (ALCAN) announced last month the pouring of the first aluminum ingot at their Kitimat, British Columbia plant. A combination hydroelectric and aluminum smelter project, it will have a capacity of 2,240,000 hp which will supply the smelter having an annual production capacity of 550,000 tons, the largest in the world. The area is spread out over territory 160 miles long and 60 miles wide.

THE CRASH of The Handley-Page crescent wing bomber—The Victor—has raised doubts about the practicability of horizontal tail surfaces located high on the vertical stabilizer. Tail trouble also caused the crash of its predecessor the HP-88. The question is whether any practical structure could be built to withstand the great torque at high speeds. The idea of the high-mounted tail is to keep it clear of the jet stream of engines mounted in the wings. The slung pod engine mounts have been used on most planes, keeping the horizontal stabilizer close to the conventional position.

PHOTOSENSITIVE, annodized aluminum sheets have been designed for photographic reproduction by standard darkroom methods by the Metalphoto Corp. of Cleveland, Ohio. The aluminum sheets are 0.020 in. thick, and come in sizes of 4 x 5 in., 8 x 10 in., and 10 x 12 in., and may be used to produce name plates, dial and watch faces, wiring diagrams, instructions, and instrument and slide rule scales.

DOERR MOTORS BRING *Dependable Power* TO ROCKWELL DRILL UNITS IN UNIQUE APPLICATION



McCulloch Motors Corporation, Los Angeles, had a unique problem—the need for a machine which would automatically drill lubrication holes in forged steel connecting rods for McCulloch's Model 33 chain saw.

To solve the problem, McCulloch designed and built this special automatic transfer type machine, utilizing two DOERR-powered Rockwell Drill Units (Model 19-150). It does the job—centers two holes at the first station and drills the two holes at the rear station on a completely automatic cycle at a rate of 63 parts per hour.

Like Rockwell, a diversified list of leading machinery manufacturers rely on DOERR motors to meet the exacting requirements of their products. The large number of designs now in production permits the adaptation of present castings, windings and mountings to new problems at minimum expense.

Bulletin 100 gives you more information on many of the special and standard designs available—write for your copy today.

YOU GET MORE WITH *DOERR!*

DOERR
Electric Corporation
CEDARBURG, WISCONSIN

DOERR ELECTRIC CORPORATION, Cedarburg, Wisconsin

Please send Bulletin 100, without obligation.

Name_____ Title_____

Company_____

Address_____

City_____ Zone____ State_____

Electric motors from 1/30 to 5 hp, for Machine Tools, Pumps, Industrial Oil Burners, Hoists, Unit Heaters, Ventilating Units and many other applications.

Wheatstone Bridge Charts

WAYNE A. RING

Aircraft Controls Development, Barber-Colman Company

THE DC WHEATSTONE BRIDGE is often used with transducers representing variables to be controlled as one or more resistance legs. When the controlled variables are at the design values, the bridge is balanced. When they differ from these values, the bridge becomes unbalanced, actuating a relay or similar device to provide corrective action.

From Thévenin's theorem, the following equation relating currents, voltages and resistances of a bridge, Fig. 1, can be derived:

$$I = \frac{E(BD - AC)}{M(A + B)(C + D) + (AB)(C + D) + (CD)(A + B)} \quad (1)$$

The resistance of the birdge circuit, R, can be expressed as:

$$R = \frac{(AB)(C + D) + (DC)(A + B) + M(A + B)(C + D)}{(A + D)(B + C) + M(A + B + C + D)} \quad (2)$$

Eq (1) is cumbersome and difficult to use when studying the effect of one variable on another. Thus, charts have been prepared from

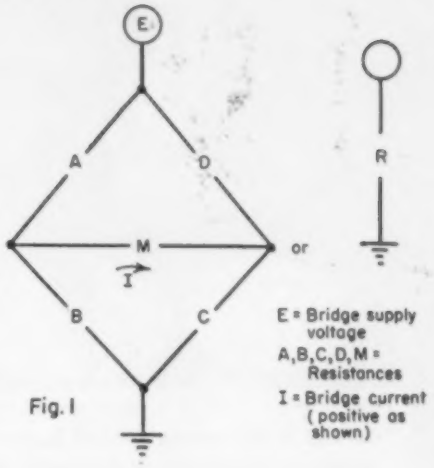


Fig. 1

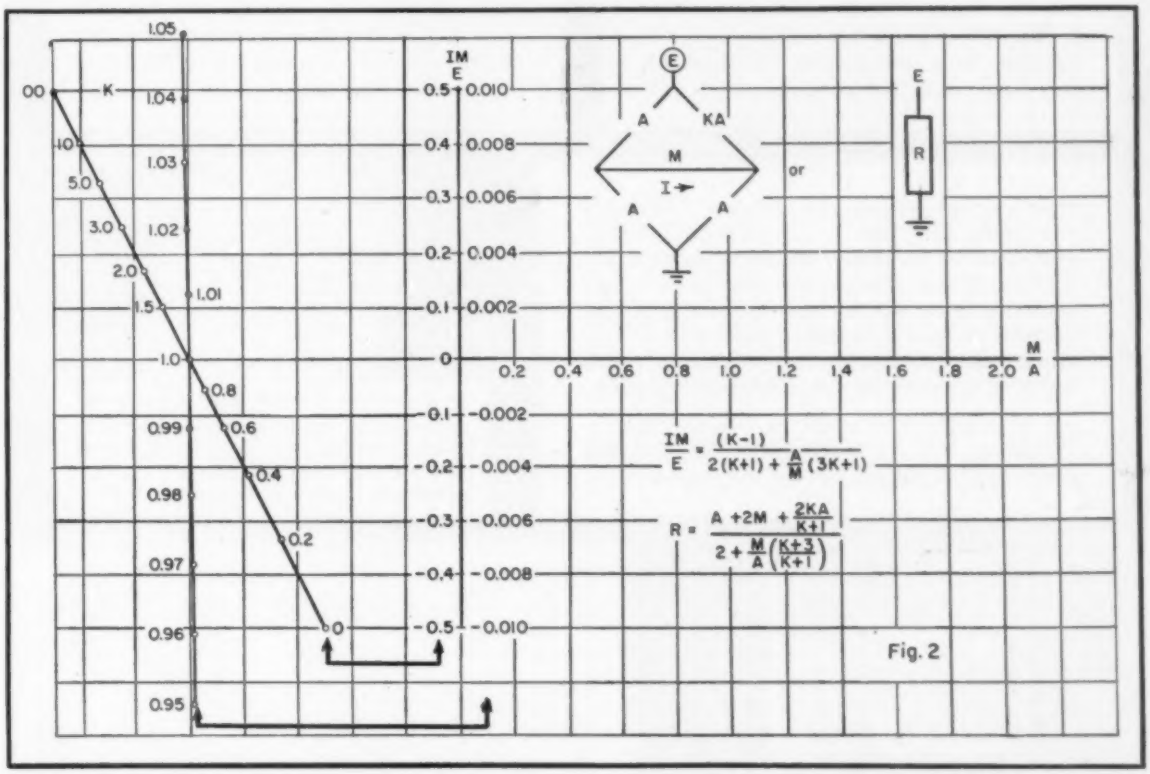
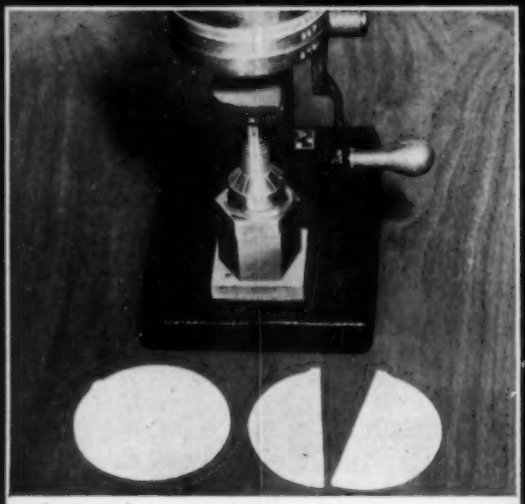


Fig. 2

(continued on page 211)

Tests show...Far greater toughness, superior flex strength...with HI-TEST 88 LUSTREX Styrene Plastic

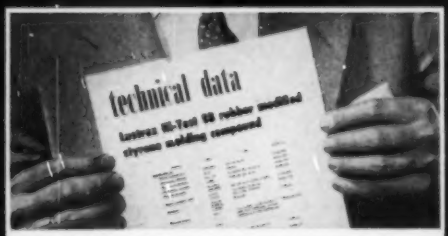


Compared to general purpose styrene—Lustrex Hi-Test 88 possesses up to 500% higher impact resistance, as indicated in this needle penetration test. Weighted needle of Toughness Tester is tripped to fall on test samples . . . *shatters* disc made of general purpose styrene (right), only *punctures* disc (left) of Lustrex Hi-Test 88.

Compared to other high impact styrenes—Lustrex Hi-Test 88 has better resistance to flexural fatigue (see demonstration above), finer surface gloss, and improved flow characteristics. It varies less in internal stress where there are adjacent thick and thin sections. Suitable for jobs involving lacquering.

Now you can provide *your* product with a real competitive advantage . . . with a stronger, tougher, more durable material: Monsanto's Lustrex Hi-Test 88 styrene plastic. *Five times tougher* than general purpose styrene, with superior resistance to strain and greater hardness, Lustrex Hi-Test 88 also possesses good appearance—high surface gloss and good color stability—plus excellent moldability.

For immediate information on how Lustrex Hi-Test 88 can help you improve the quality and sales power of your product, just use the coupon below.



For your Materials Data Book – Basic engineering data you'll want for your permanent file on materials. Includes physical properties and performance characteristics, plus pertinent test information. Mail the coupon today for this valuable reference material.

MONSANTO

SERVING INDUSTRY . . . WHICH SERVES MANKIND

MONSANTO CHEMICAL COMPANY, Plastics Division, Room 2110, Springfield 2, Mass.
Please send me a copy of your booklet, "Design for Sales," and technical data sheet on Lustrex Hi-Test 88 styrene plastic.

Name & Title _____

Company _____

Address _____

City, Zone, State _____

(*Continued from page 209*)

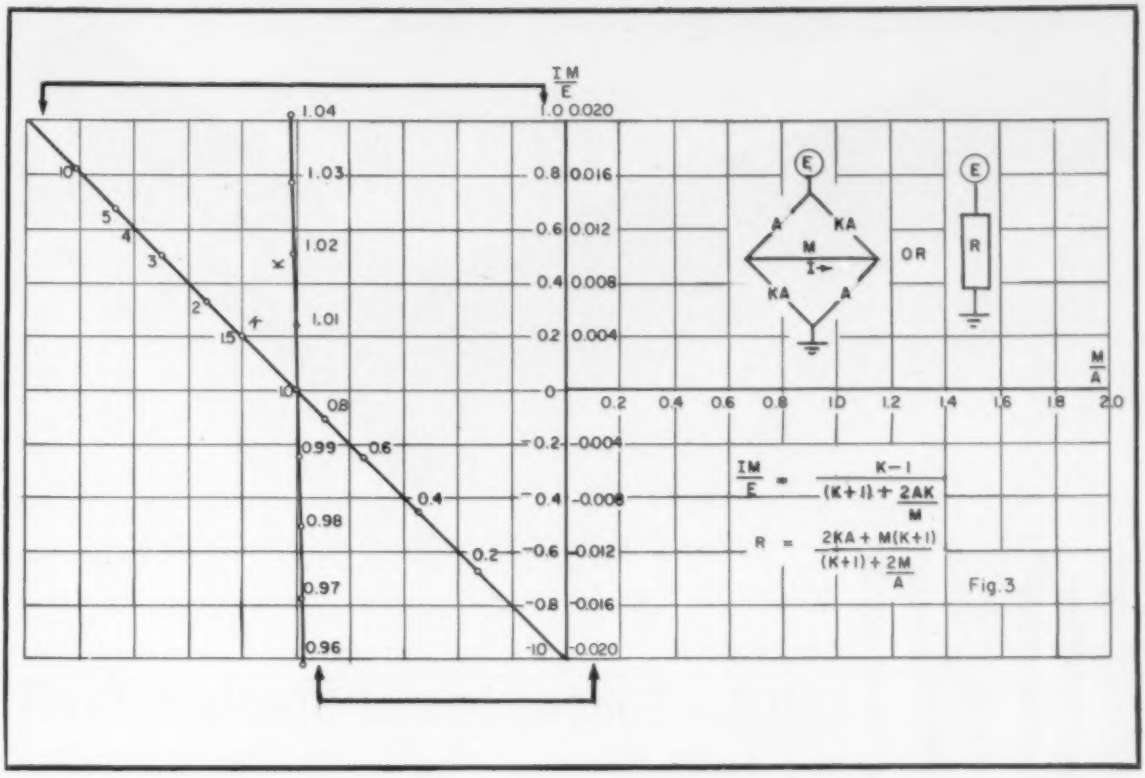


Fig. 3

the equation for several commonly used circuits. Eq (2) is useful for determining the variation in E when the bridge is used in series with a "dropping" resistor.

The simplest circuit, represented in Fig. 2, has one variable leg with a resistance of magnitude KA. Knowing the ratio M/A and K, a line connecting these two values on the chart will provide a value of IM. Since M and E are known, I can be evaluated.

If negative values of I/ME are obtained, the current through the resistance M is opposite to that shown. If KA is put in the opposite leg shown, the graph remains unchanged. If KA is in an adjacent leg, the graph remains unchanged while the positive direction of current reverses.

Fig. 2 has two IM/E and K scales. The corresponding scales are marked on the graph. If values shown are not in the range that is desired, a new graph can be constructed as follows:

1. Mark off the M/A and IM/E scales linearly to any convenient scale.

2. Draw the K line through the point $IM/E = 0$, $M/A = -1$, with a slope of minus one.

3. Choose convenient values of K and calculate $\frac{1}{2}\left(\frac{K-1}{K+1}\right)$. Find this value on the IM/E scale and draw a line through it parallel to the M/A scale. Where this line crosses the K scale, record the value of K used to calculate

$$\frac{1}{2}\left(\frac{K-1}{K+1}\right).$$

Fig. 3 solves the equation

$$\frac{IM}{E} = \frac{(K-1)}{(K+1)+\frac{2AK}{M}}$$

It is similar to Fig. 2 and is constructed in the same manner except that in step (3) $\left(\frac{K-1}{K+1}\right)$ is used instead of $\frac{1}{2}\left(\frac{K-1}{K+1}\right)$.

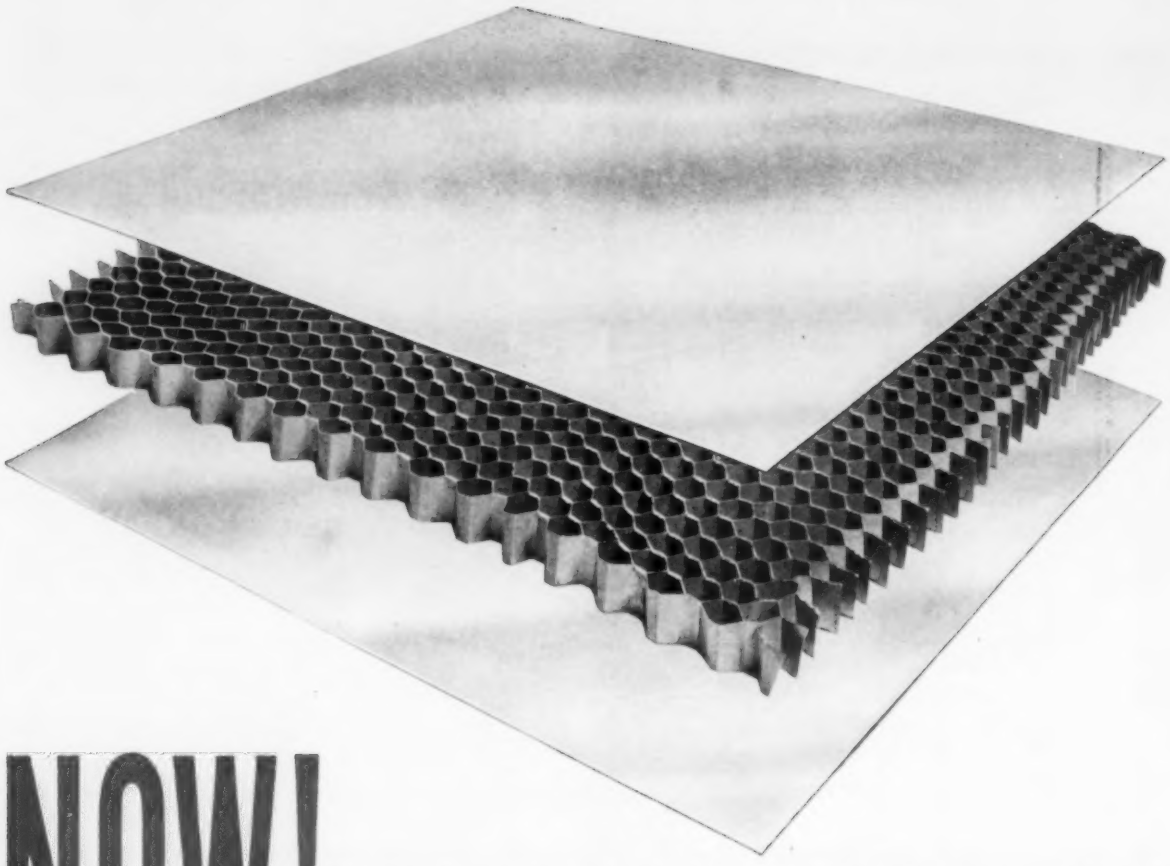
The curves of Fig. 4(A)-(C) represent a bridge with two corners, designated by $A(1-P)$ and $A(1+P)$, containing rheostats. These graphs solve the equation

$$\frac{IM}{E} = \frac{(K-P)}{2+\frac{A}{M}(2-K^2-P^2)}$$

To construct the graph, the M/A and IM/E scales are drawn in the same manner as for Figs. 2 and 3. To construct the K scale, choose convenient values of K and P and calculate $U = \frac{K^2+P^2-2}{2}$ and $V = \frac{K-P}{2}$. At a distance U on the M/A scale (this value is always negative) and a distance V on the IM/E scale label the point with the value of K and P used to calculate U and V.

Fig. 4(A) has constant P curves and curves (dash lines) showing

(*continued on page 213*)



NOW! Cellular Sandwiches of Stainless Steel for Aircraft

This cellular mat of Armco 17-7 PH Stainless strip is the filler that is sandwiched between two stainless steel sheets to make an aircraft panel.

How It Works

The 2 to 3-thousandths of an inch thick core material, when bonded into panels with adhesives or by brazing, permits the skins or faces of the panels to be stressed to their yield strength without premature buckling. The core carries the shear and compressive loading.

Why It's Strong

Panels have very high strength-to-weight ratio due to their design, and because both filler strip and cover sheets are made of Armco 17-7 PH. This precipitation-hardening stainless steel develops typical tensile yield strengths of 180,000 psi, and even higher *compressive yield strengths,* through double low-temperature heat treatment.

Where Used

The cellular 17-7 PH stainless panel is under development for jets, rockets and missiles because of its great strength at temperatures up to 900 F. Yet it can be used in cold or hot service for tail pipe shrouding, leading edge sections, bulkheads, fins, control surfaces, after-burner cases, and many other applications requiring corrosion resistance, lightness and enduring strength.

Ask About This Stainless

Just write us at the address below and we will send you complete information on the precipitation-hardening stainless steels, Armco 17-7 PH and Armco 17-4 PH.

ARMCO STEEL CORPORATION

4684 CURTIS STREET, MIDDLETOWN, OHIO

ARMCO®

SHEFFIELD STEEL • ARMCO DRAINAGE & METAL PRODUCTS, INC. • THE ARMCO INTERNATIONAL CORPORATION

(Continued from page 211)

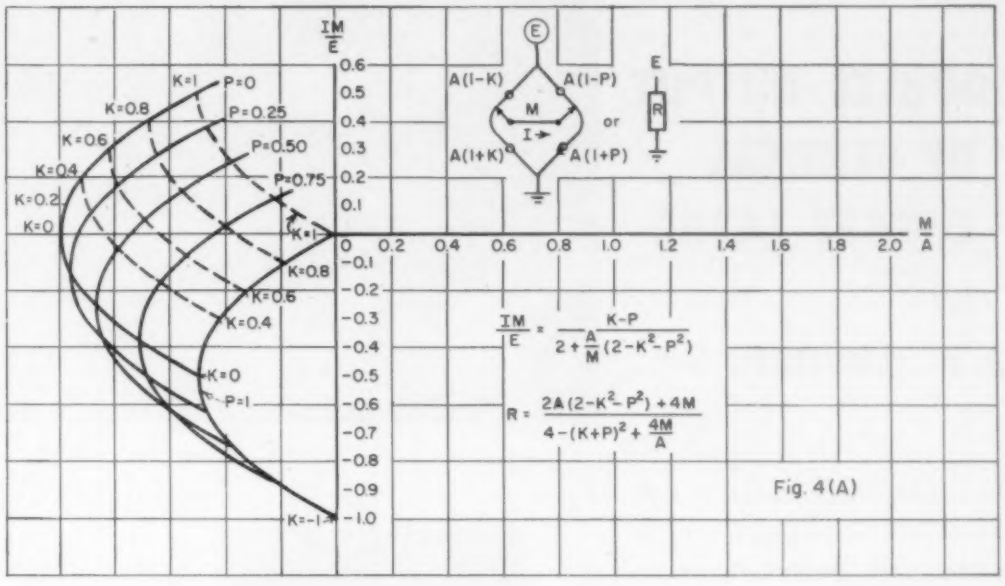


Fig. 4(A)

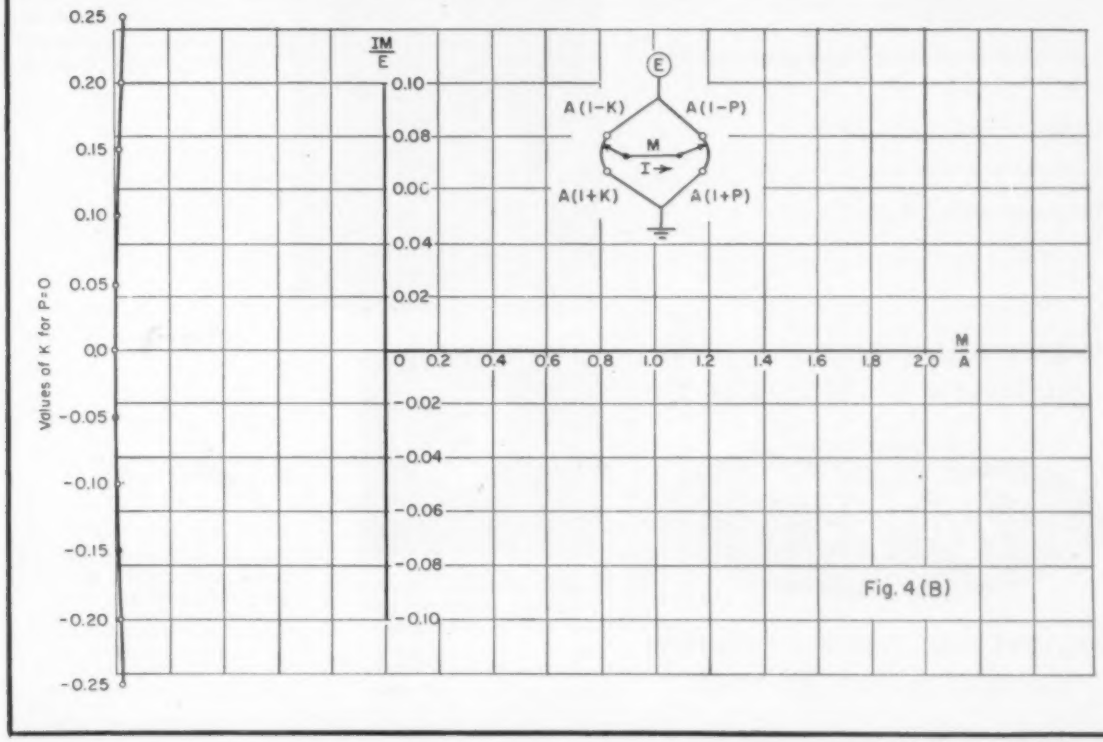


Fig. 4(B)

(continued on page 215)

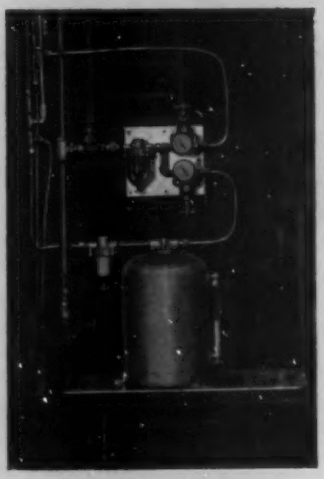
Norgren Spray-Lube System

DOUBLES OUTPUT OF VERTICAL TURRET LATHE at O. K. RUBBER, INC.

4 Spray-Lube lines give full spray coverage over 14¼" cutting edge of tool.

On roughing and finishing a straight ribbon tread on cast aluminum tire capping mold, Norgren Spray-Lube:

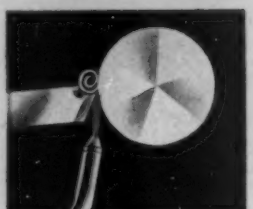
- stepped up surface cutting speed from 45 to 75 rpm.
- increased depth of cut.
- eliminated welding of chips on cutting tool.
- ended galling of work pieces.
- reduced tool maintenance.
- improved quality of work.



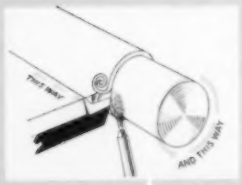
Spray-Lube control panel and liquid reservoir are centrally located for several machines.

WRITE FOR COMPLETE DATA NORGREN BLUEPRINT SL-2

C. A. Norgren CO.
3428 So. Elati, Englewood, Colo.



Coolant where you need it ... spray is applied to work area from any required direction to thoroughly lubricate critical contact areas between cutting tool and work piece.



Step Up Production Speed. Rapid cooling at the cutting point will enable you to increase both the speed, and the feed of the cutting tool, and still improve workmanship and tool life. Notable increases in machine output have resulted.

PIONEER AND LEADER IN OIL-FOG LUBRICATION FOR 26 YEARS

VALVES FILTERS HOSE ASSEMBLIES REGULATORS LUBRICATORS

(Continued from page 213)

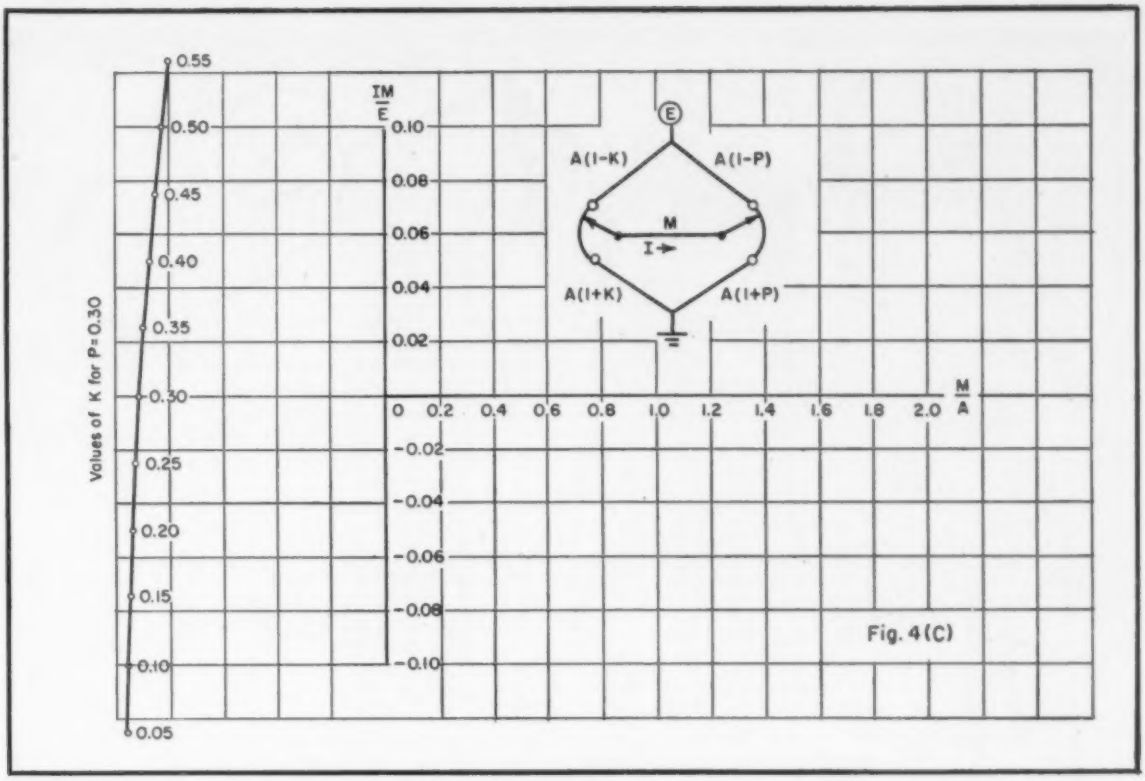


Fig. 4(C)

various K values. All the constant P and constant K curves are parabolas. It is possible to use the graph in slide rule fashion by using one P curve with various K's labeled and shifting it to the appropriate P position. Changing the sign of P or K reverses the current direction.

EXAMPLE 1.

Given: $E = 25$ v

$M = 100$ ohms (relay coil resistance)

Relay sensitivity = 0.0005 amps

$A = 100$ ohms

$K = 1$ at initial condition

$K = 1.02$ at second condition

Will the relay be actuated before K reaches the second condition?

SOLUTION: In Fig. 2, draw a straight line between $K = 1.02$, and $\frac{M}{A} = \frac{100}{100} = 1$. This line crosses the $\frac{IM}{E}$ scale at $\frac{IM}{E} = 0.0024$. Therefore, $I = \frac{(0.0024)\ (25)}{100} = 0.0006$ amps which means the relay will operate before the second condition is reached because this bridge current is greater than 0.0005 amps, the coil pull-in current.

EXAMPLE 2.

If two transducers are used and the bridge configuration is such as that in Fig. 3, it might be desirable to know what value of K would be needed to actuate the same relay. In this case draw a straight line between points

$$\frac{M}{A} = 1 \text{ and } \frac{IM}{E} = \frac{(0.0005)\ (100)}{25}$$

$= \pm 0.002$. It crosses K at 1.008, or at 0.992. Current I is positive with $K = 1.008$ and negative when $K = 0.992$.

EXAMPLE 3.

Given: $A = 100$ ohms

$E = 100$ v

$M = 100$ ohms (see Fig. 5)

It is desired to know I when $K = 0.2$ and $P = 0.5$.

On Fig. 4(A), connecting point $\frac{M}{A} = \frac{100}{100} = 1$ with $K = 0.2$ on the $P = 0.5$ curve, the line crosses the $\frac{IM}{E}$ line at approximately —0.08.

Since M and E both equal 100, $I = 0.08$ amp and is flowing in the opposite direction to that shown on the graph.

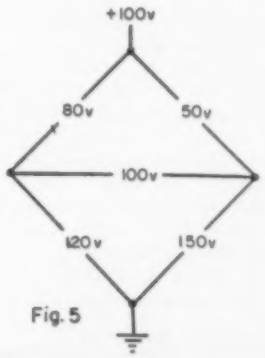
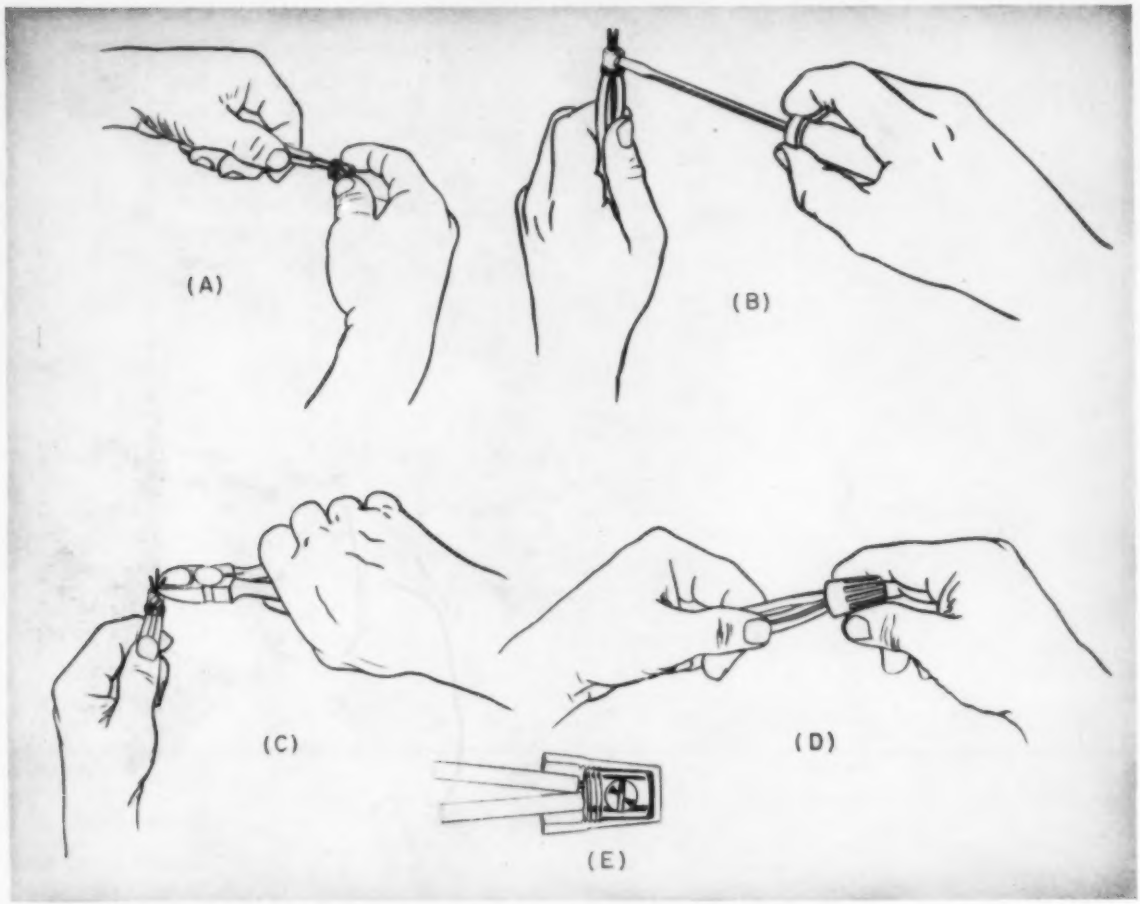


Fig. 5



HOW CONNECTOR IS APPLIED: (A) Ends of wires are stripped as usual and then inserted in set-screw sleeve. (B) Tighten set screw (C) Clip off surplus wire, flush with sleeve. (D) Screw shell into place over sleeve until tight. (E) Cross-sectional drawing of completed assembly. This connector is UL-approved for all branch circuit wiring up to 600 v.

Set-Screw Connector for Electrical Wiring

A connector recently introduced permits the connecting of branch circuits, fixtures, machines, appliances as well as temporary setups such as laboratory breadboards without twisting, taping or soldering the wires involved. Only a screw driver is required to tighten the connector's set screw. The set screw secures the wires to be connected within a brass sleeve, which is threaded to match the phenolic cap that screws on to cover and insulate the entire connection, wires, set screw and all.

This phenolic shell is easily unscrewed for inspection and the entire connection can quickly be disassembled to make circuit changes or to tie in additions. The unit is reusable.

The new connector is UL-approved for all types of branch circuit wiring up to 600 v. UL-tests for mechanical strength of joint, current loss and heat rise were made with wires inserted untwisted into the connector. It is reported that in every case the new device far surpassed required performance.

The connector is available in three sizes for wire combinations ranging from four No. 18 wires through six No. 14, two No. 10 and one No. 12. The two larger sizes are primarily intended for contractor work as pressure cable connectors on conduits, armored cable, non-metallic cable and open wiring. Ideal Industries, Inc., 1446 Park Ave., Sycamore, Ill.

For more information—
Circle 1, inside back cover

Stepless Speed Control For Fhp Motors

This variable speed control is currently being manufactured in motor sizes for 1/18 to ¾ hp. Each packaged control consists of three elements: the motor, the control enclosure, and the single-point switch. Speed range is 35 to 1; with optional dual range control; speed range is widened to 100 to 1.

This control is designed especially for applications where close speed control over a wide range is necessary. Such applications include machine tools, coil winders, printing and textile machines, shears, wire stranders and spoolers, box making and folding machines, paper making and printing machines, mixers and agitators, pumps, elevators and conveyors, woodworking machinery, laboratory and testing equipment.

Speed regulation is claimed to be excellent, speed being essentially independent of load as torque is varied from full load to 20 percent of full load value. Under overload conditions, a current limiting device allows motor to slow down to complete stall without dangerously high currents. On release from overload, accelerating torque is produced as fast as safe motor current limits will permit.

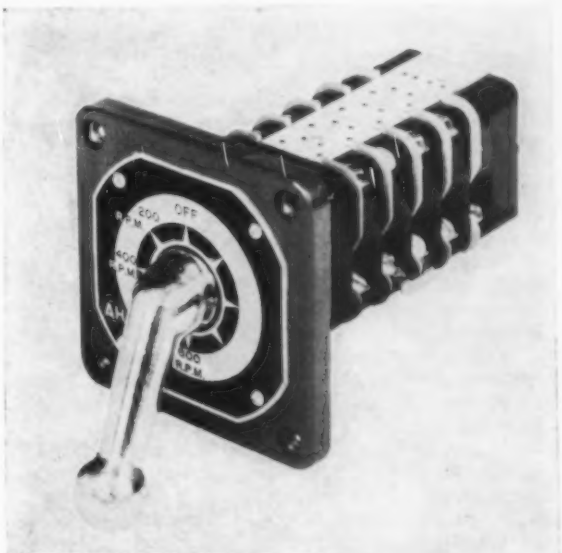
Series motors are specially wound and are available in all NEMA enclosures smaller than NEMA 203 frame. Gear reduction types are available. The series-wound motor will operate on a-c or d-c current, and uses both components in the armature to produce available torque. Since the output of the single half-wave rectifier tube used in this control consists of both a-c and d-c currents, the series motor does not have to be derated to the same extent as the shunt motor for continuous duty, with the result that frame size can be considerably reduced.

Control elements are enclosed in a NEMA Type 1, general purpose box. Adjustable controls, magnetic starter "plug-in" parts, and the thyratron tube are located just back of the removable door. All circuit connections are to one terminal block for faster connections. All small and fragile parts used, such as small capacitors, resistors and rectifiers, are first wired to a standard octal plug and then encased in plastic. The resultant "plug-in" part is reported to be extremely durable, and this construction has the added advantage of being moisture proof, dustproof and shockproof.

This unit's switch permits a single control to do the work of many separate push buttons and magnetic starters. Pushing the handle opens all circuits and disconnects all controls. Turning to a new position does not energize any passed circuits. To complete the circuit, it is necessary to pull the handle to "start." Jogging, inching, creeping in either forward or reverse, regenerative braking in stopping, and several pre-set speeds can be combined in one switch. Up to 16 separate functions in addition to stop and start are controllable from the one control arm. Arrow-Hart & Hegeman Electric Co., Hartford, Conn.

For more information—Circle 2, inside back cover

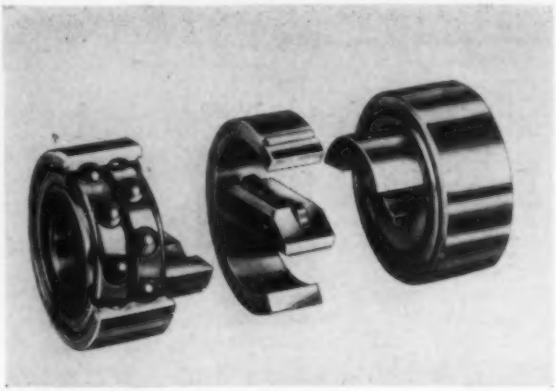
ADJUSTMENTS FOR CONTROLS, "plug-in" components and the unit's thyratron tube are located just inside the control enclosure's door, providing easier access.



THE SWITCH'S ONE CONTROL ARM can handle up to 16 separate functions in addition to stop and start.

CONTINUED ON PAGE 218

Permits Torque in One Direction Only



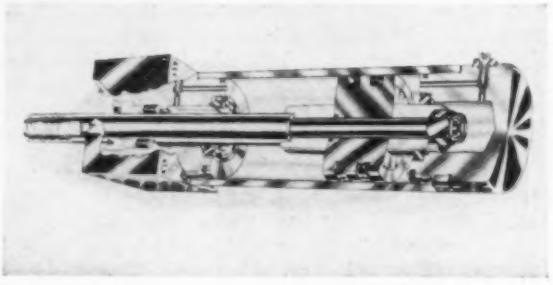
A new device transmits torque while positively preventing reverse torque action. The device transmits torque in both clockwise and counterclockwise directions and can be used to lock a driven mechanism in any angular position.

Previously produced almost entirely for military equipment, the device is now available to manufacturers for machinery and industrial equipment. Ahlberg Bearing Co., 3025 West 47 St., Chicago, Illinois.

For more information—Circle 3, inside back cover

Hydraulic Cylinders for Air or Oil

This cylinder is said to be the smallest cylinder, according to bore size, on the market, saving up to as much as 40 percent in mounting space. It is now offered with the same mounting diameter in either an air cylinder or a low-pressure hydraulic cylinder, for a maximum of 200 psi air or a maximum of 750 psi oil. The new line is available "off-the-shelf" in six standard styles of mounting, with bores from 1 through 4 in. and strokes from 1 through 12 in. in even increments of 1 in. Tomkins-Johnson Co., Jackson, Michigan.



For more information—Circle 4, inside back cover

Easy-to-Replace Pilot Light

Pilot light assemblies are now available that can employ any of the telephone type incandescent bulbs which have slide bases. A feature, unusual in slide base lampholders, is the reported ease of lamp replacement. No extractors or other tools are required when removing one of this new series of pilot lights.

A choice of screw and friction-fitted caps with flat and convex lenses of $\frac{3}{8}$ and $\frac{1}{2}$ in. dia is provided. For wide angle visibility, a unique screw cap with stovepipe lens (molded of glass or plastic) is fitted over a lamp brought unusually far forward in the panel.

Reduced back projection results with advantage when the space back of the panel is shallow. Mounting is simply done in a single $\frac{9}{16}$ in. hole. Adjacent units may be placed as close as $\frac{3}{4}$ in. (center to center). These pilot lights may be had with soldering terminals or binding screws. Samples of these new components for design purposes will be sent without charge if request is made on company letterhead. Dialight Corporation, 60 Stewart Avenue, Brooklyn 37, New York.

For more information—Circle 5, inside back cover

Air Valve "Senses" Trouble

An air control valve that "senses" malfunctioning shuts itself off when any of its components does not operate normally. The heart of the safety feature is a "cut-off" unit attached to the pilot section casting. This cuts off the air supply to the pilot section in case of failure. The valve cannot be actuated again until an authorized person inspects and fixes the valve.

The new device is an a-c solenoid-pilot operated, three-way model. It may be said to consist of two valves in a common housing combined with the cut-off unit. It has a single inlet port, a single cylinder or outlet and two interconnected exhaust ports. There are two pilot sections with a common air supply, but with individual exhaust ports and solenoids.

The new valve will handle up to 600 cycles per min. Main valve pressures range from 30 to 125 psi air, with pilot pressure of 40 to 125 psi air. Maximum temperature is 175 F. Operating voltage is rated at 115 v, ± 10 per cent. Weight is 14 lb and inlet pipe size $\frac{3}{4}$ in. Dept 3104, Ross Operating Valve Co., Detroit.

For more information—Circle 6, inside back cover

CONTINUED ON PAGE 220

tubing shapes up like this at OSTUCO

We start with these basic shapes . . . then we forge and fabricate carbon and alloy steel tubing to your exact specifications all under one roof. One purchase order takes care of all details. If you would like to know more about our "single source service," send for our newest catalog, "OSTUCO Tubing" . . . better yet, send your blueprints for prompt quotation.

OSTUCO TUBING

SEAMLESS AND ELECTRIC WELDED STEEL TUBING —Fabricating and Forging

OHIO SEAMLESS TUBE DIVISION
of Copperweld Steel Company • **SHELBY, OHIO**
Birthplace of the Seamless Steel Tube Industry in America

SALES REPRESENTATIVES: BIRMINGHAM • CHARLOTTE • CHICAGO CLEVELAND • DAYTON • DENVER • DETROIT (Ferndale) • HOUSTON • LOUISVILLE LOS ANGELES (Beverly Hills) • MOLINE • NEW YORK • NORTH KANSAS CITY PHILADELPHIA • PITTSBURGH • RICHMOND • ROCHESTER • ST. LOUIS • ST. PAUL SALT LAKE CITY • SAN FRANCISCO • SEATTLE • TULSA • WICHITA
CANADA, RAILWAY & POWER CORP., LTD.
EXPORT: COPPERWELD STEEL INTERNATIONAL COMPANY
117 Liberty Street, New York 6, New York

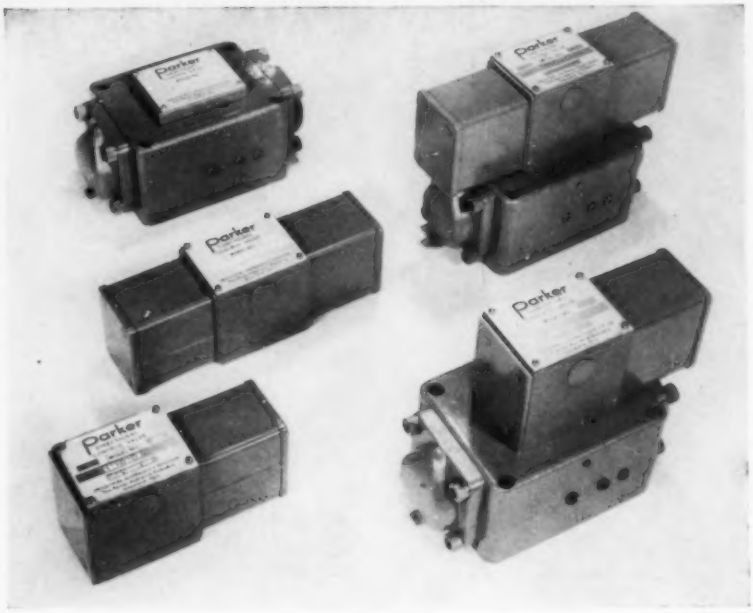
Directional Valves for Hydraulic Systems

All these new valves are designed for use in hydraulic (oil) systems with operating pressures up to 2000 psi. All are for gasket-type mounting. Subplates are available from the maker, if required.

The five new designs differ, principally, in the methods of actuation. These are: pilot operated, solenoid operated (single or double) and solenoid controlled-pilot operated (single or double solenoid). Solenoid-operated valves are rated at a maximum capacity of 3 gpm. Either of two subplates, or equivalent mounting pad, may be used. One subplate, for flows up to 1 gpm, has $\frac{1}{4}$ in. pipe threads; the other, for flows to 3 gpm, has $\frac{3}{8}$ in. pipe threads.

Pilot operated, and solenoid controlled-pilot operated valves are rated at a maximum capacity of 22 gpm. Subplate is tapped for $\frac{3}{4}$ in. pipe. Pilot pressure may be 50 psi minimum up to the 2000 psi valve capacity. Normally the solenoid controlled-pilot operated valves are arranged for internal pilot pressure source. They can be furnished for use with an external pilot pressure source.

From one to six spool types are offered in each design. All spool types interchangeable in the same body. An unusual offering is that of a tandem spool for the 3 gpm valve (pressure open to tank, cylinder ports blocked in neutral—tank port will take full 2000 psi). Spools may be spring centered, spring offset, or two position-no spring.



Compactness is exceptional without sacrificing the advantage of low pressure drop. The 3 gpm solenoid-operated valve is only $2\frac{3}{4}$x$3\frac{1}{2}$x$9\frac{1}{4}$ in.

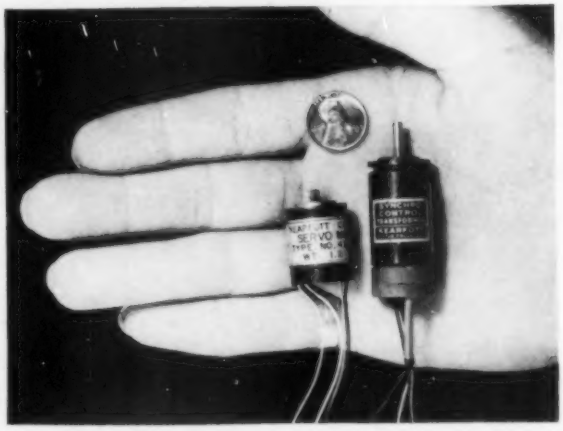
Solenoids are normally furnished for 115 v., 50 or 60 cycle a-c service. Solenoids for other voltages and frequencies can be supplied when specified, including solenoids for dc. A new shock mounting design of a-c solenoid is used. Stainless steel push pins eliminate the magnetic resistance of plain steel pins. Parker Appliance Co., 17325 Euclid Ave., Cleveland 12, Ohio.

For more information—
Circle 7, inside back cover

Servo System Components Only ¾ in. Dia

These servo motors and synchros are part of a new line of this type of components, featuring straight-thru bore and integral stator-housing construction. Stainless steel housing, stainless laminations and, where necessary, stainless ball bearings coupled with the "potted" stator construction hermetically seals the windings and is asserted to make possible truly corrosion resistant components. The servo motor on the left in the photograph is $\frac{3}{4}$ x 15/16 in. long. It has a no-load speed of 6,500 rpm and a stall torque of 0.1 oz-in. Power input is 1.5 w and voltage input is 1.8 v.

Synchro transmitters, control transformers and differentials with maximum error limits of 10 minutes from electrical zero for use in conjunction with motors such as that described above provide sensors and error detectors. These units measure $\frac{3}{4}$ x 1.658 in. long and weigh 1.75 oz. Kearfott Co., Inc., 1378 Main Ave., Clifton, N. J.

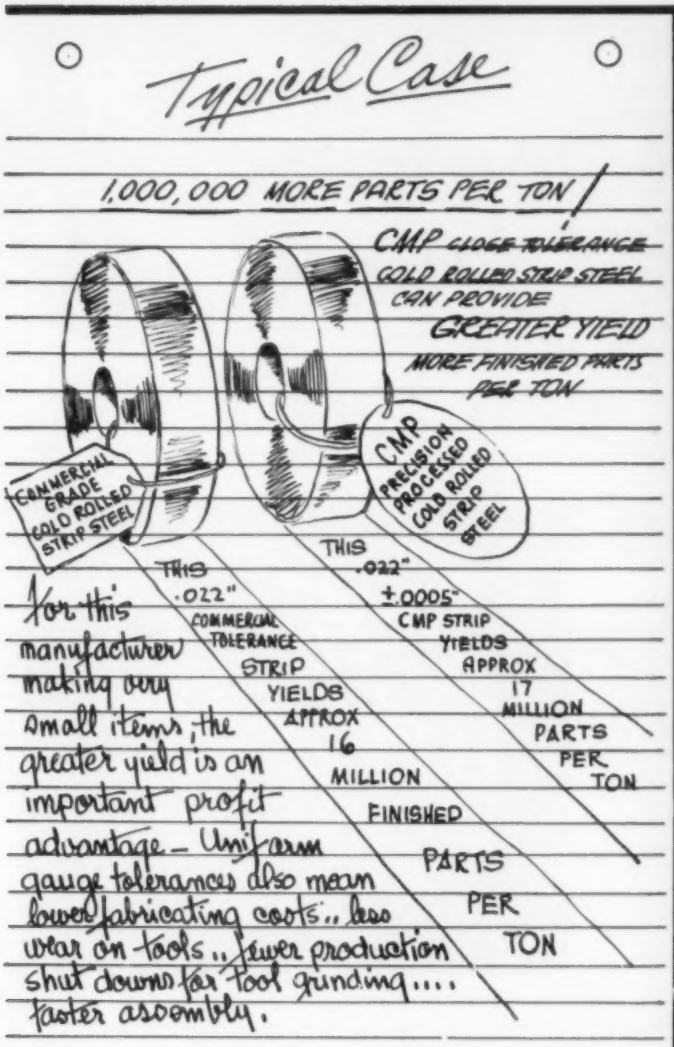


For more information—Circle 8, inside back cover

—CONTINUED ON PAGE 222

CMP COLD ROLLED STRIP STEEL OFFERS

some realistic ways . . .


Typical Case
1,000,000 MORE PARTS PER TON!
CMP CLOSE TOLERANCE COLD ROLLED STRIP STEEL CAN PROVIDE GREATER YIELD MORE FINISHED PARTS PER TON
COMMERCIAL GRADE COLD ROLLED STRIP STEEL
CMP PRECISION PROCESSED COLD ROLLED STRIP STEEL
THIS .022" COMMERCIAL TOLERANCE STRIP YIELDS APPROX 16 MILLION FINISHED PARTS PER TON
THIS .022" ±.0005" CMP STRIP YIELDS APPROX 17 MILLION PARTS PER TON
For this manufacturer making very small items, the greater yield is an important profit advantage — Uniform gauge tolerances also mean lower fabricating costs.. less wear on tools.. fewer production shut downs for tool grinding.... faster assembly.

TO REDUCE END-PRODUCT COSTS THROUGH PRECISION GAUGE TOLERANCES

CMP's precision rolling process permits production of cold-rolled strip steel as thin as .001" to split-hair across-the-width gauge tolerances not obtainable by other rolling methods. This unique precision is reflected in less square footage loss through oversize variation, less wear on tools, fewer rejections and faster assembly where close fitting is encountered.

CMP processes also permit close control of physical characteristics to develop the combination of physicals best suited to fabricating and service requirements of the application.

We'll be happy to work with you to develop specifications and processing methods to enable you to make the best possible product at the lowest possible cost.

the Cold Metal Products co.

GENERAL OFFICES: YOUNGSTOWN 1, OHIO

PLANTS: YOUNGSTOWN, OHIO AND INDIANAPOLIS, INDIANA

SALES OFFICES: New York • Cleveland • Detroit • Indianapolis; Chicago • St. Louis • Los Angeles • San Francisco

LOW CARBON, HIGH CARBON (Annealed or Tempered), STAINLESS AND ALLOY GRADES, ELECTRO ZINC COATED ARE AVAILABLE FROM:

THE COLD METAL PRODUCTS CO. OF CALIFORNIA
6600 McKinley Avenue, Los Angeles — Phone: PLeasant 3-1291

THE KENILWORTH STEEL CO., 750 Boulevard, Kenilworth, New Jersey
Phones: N. Y., COrtlandt 7-2427; N. J., UNionville 2-6900

PRECISION STEEL WAREHOUSE, INC.
4425 W. Kinzie, Chicago — Phone : COlumbus 1-2700

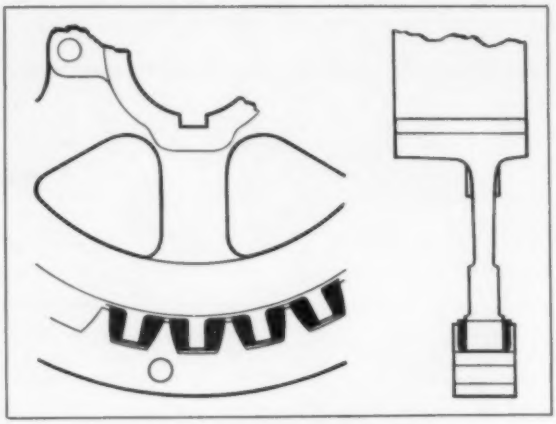
Rubber Drive Helps Cure Misalignment

Availability of a rubber block drive for general use on powered industrial equipment has been announced by its manufacturer, who developed it primarily for use on its own line of torque converters and disconnecting fluid power take-offs. This type of drive is said to absorb both angular and parallel misalignment.

In appearance, it resembles one-half of a gear-tooth-type flexible coupling, except that the gear teeth are large rubber blocks molded from one of the new synthetic rubbers.

The mating driving ring, precision-shaped on a gear-cutter, bolts directly to the flywheel. Although the rubber block drive is generally mounted to absorb both angular and parallel misalignment, it can be easily adapted to form a piloting coupling handling angular misalignment only.

A typical example of an application where the new drive has cured misalignment problems is in the oilfields, where equipment manufacturers have installed it on compressors. It appears the drive will prove equally successful in the near future on pumps, independent transmissions, generator drives. Twin Disc Clutch Co., Racine, Wis.



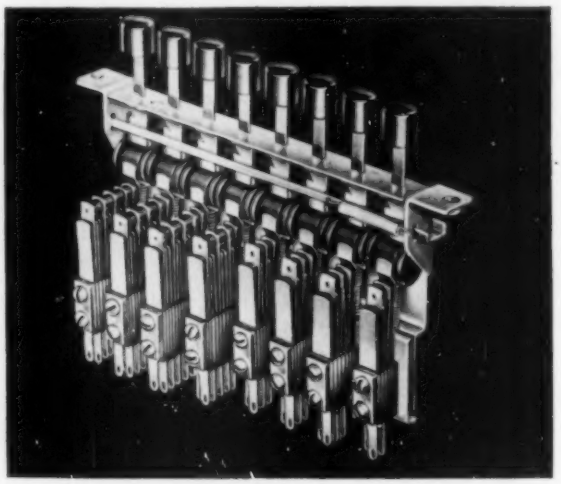
For more information—Circle 9, inside back cover

Switches With Four to Twelve Stations

Two new interlocking pushbutton switches are available in capacities of four to twelve stations. Each station may be equipped with various combinations of contact assemblies. All stations are interlocked, so that depressing any button releases any other previously operated button. Several optional arrangements are also available.

Switches in the two new series are designed for use on communication equipment, alarm and signalling apparatus, radio and television broadcast and control equipment, test panels, industrial process control units, railway communications systems, electronic devices, controls and instruments. Donald F. Mossman, Inc., Brewster, N. Y.

For more information—Circle 10, inside back cover



Melting Wax Compound Actuates Thermostat

A thermostat actuated by a compact thermal unit has been developed for use in pressurized cooling systems of automobile and truck engines and industrial equipment. The thermal unit is charged with a special wax-like composition instead of conventional volatile liquids or gases. The wax melts as the water in the engine cooling system begins to heat up and solidifies again upon cooling. A pronounced increase in volume of the wax-like charge upon melting serves to actuate the thermostat valve, allowing water to circulate through the radiator.

According to the manufacturers, cooling systems in modern automobile and truck engines use a pressure cap to pressurize the cooling system, in order to reduce the size of the radiator, lower its cost and provide a larger safety factor in extremely hot climates.

The new element is admirably suited for operation in any such type of pressurized system, since it is unaffected by pressure built up within the system. Robertshaw-Fulton Controls Co., Box 400, Knoxville, Tenn.

For more information
Circle 11, inside back cover

CONTINUED ON PAGE 224

HERE'S PROOF: You can always count on Continental for every fastener need!

Continental Produces Over 1,756,000 Styles and Sizes of Standard Screws Alone!

. . . to quickly meet your every demand

Whether your needs are special or regular fasteners, always count on Continental for satisfaction. Their total of over 1,756,000 different sizes and types of standard screws alone give you a greater selection than any other fastener producer.

You can be sure that their design engineers and production specialists will give you the benefit of their experience with every standard or special fastener.

Profit from this experience. Put them to work for you today. Call direct or through your local distributor. Continental has proven for 50 years that it can better satisfy your every need.

Manufacturers of HOLTITE Fastenings

INC. CONTINENTAL SCREW COMPANY 1904

50th Anniversary

CONTINENTAL SCREW COMPANY

New Bedford, Mass., U. S. A.

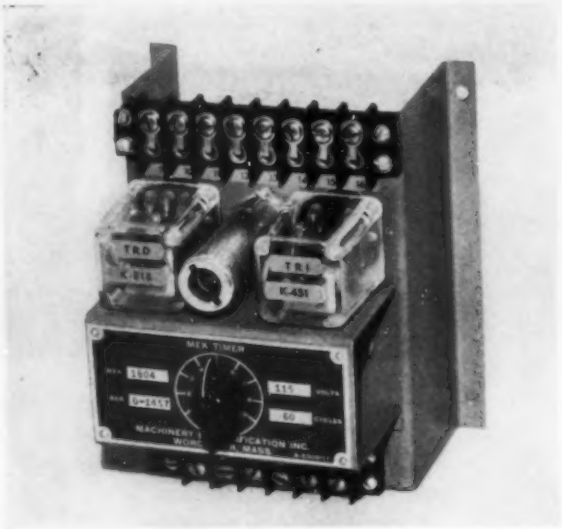
Voltage Regulated Time Limiter

Designed for time interval or time limiting applications, a voltage-regulated delay relay is said to have repetitive accuracy within ± 2 percent with line voltage variations of up to ± 10 per cent. Length of timed interval desired is controlled by a potentiometer, which regulates the rate of voltage rise on a timing capacitor. The time resets instantaneously after completion of a cycle.

Plug-in relays, of sealed construction for protection against dust and dirt, can be easily examined during operation. A cold cathode tube, used in a circuit that aids tube life, requires no warm-up time.

The new device is available in two timing ranges, 0.04 to 16 sec. and 0.04 to 4 sec. Open or closed models are available as well as remotely adjustable units. Two or more units may be connected together for complex operations.

Power consumption of the relay is 8 w and it requires a 110 v, 50 to 60 cycles line. Machinery Electrification, Incorporated, Northboro, Massachusetts.



For more information—Circle 12, inside back cover

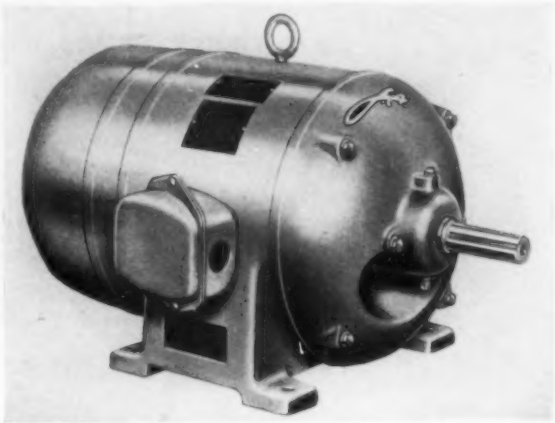
Brakemotor Takes Less Space

Short overall length is made possible in this integral brakemotor by utilizing the motor-end bracket as a part of the brake. This development is expected to permit the use of brakemotors in many applications where they were formerly prohibited by space limitations.

These units utilize disc brakes and are available in NEMA motor frame sizes from 203 to 326. Brakes are designed to furnish maximum continuous-duty torque from 3 ft-lb in the smaller sizes to 50 ft-lb in the largest sizes. Many electrical and mechanical modifications are available.

An external wear indicator eliminates cover removal and constant brake-lining inspection. It shows that the brake is operating properly at each engagement. Brake adjustment is also simplified, since one torque-adjustment nut sets it for any rating to maximum. External parts are cast iron. Louis Allis Co., Milwaukee 7, Wis.

For more information—Circle 13, inside back cover



A NEW HIGH-SPEED PRECISION SWITCH employs contact plates molded with high quality mica-filled resin. Although the unit is only 2 in. dia and 1 in. long, the same technique applies to larger and to subminiature commutators of standard form used for telemetering, for thermocouple and strain gauge sampling, for parameter display, for drift correction of multiple amplifiers. The switch is available with any of a large variety of contact materials selected according to application and with a variety of features such as number of contacts, number of poles and sampling rates. It can be supplied with single or double-ended shaft or integrally mounted with its own driving motor. General Deviced, Inc., P. O. Box 253, Princeton, N. J.

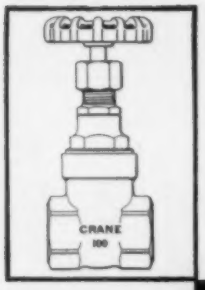
For more information—Circle 14, inside back cover

SEALED, RUGGEDIZED PANEL METERS are being made with d-c ranges showing any practical scale from 300 microamperes to 800 milliamperes. They are available in two sizes, 2½ and 3½ in. dia. Approval of these panel meters has been obtained from a government agency. Simpson Electric Co., 5200 W. Kinzie St., Chicago 44, Ill.

For more information—Circle 15, inside back cover

CONTINUED ON PAGE 226

NEW* brass gate valves by CRANE



No. 410,
100-Pound

No. 438,
125-Pound

No. 437,
150-Pound

* NEW SHAPE... NEW STRENGTH

for 3 All-Time CRANE *favorites*

Here are valves that didn't have to be changed . . . because each has long been the best in its class. But Crane found ways of improvement to give you an even better buy for your brass valve dollars.

For example—here is greater strength, greater rigidity, made possible by the new cylindrical upper body . . . the same basic shape as high-pressure steel valves. Here, too, is an improved stuffing box that screws *into* the bonnet—also better stem support to assure truer alignment and minimize wear on the packing.

And not to be overlooked is their clean, modern appearance—a very desirable advantage for all of your "exposed" installations. Sizes ¼ to 3 in. Ask your Crane Representative all about this improved brass valve line next time he calls.

just off the press...
new four-page folder with complete facts including sizes, prices and dimensions. Send for yours today. Ask for Brass Valve Folder AD1944.

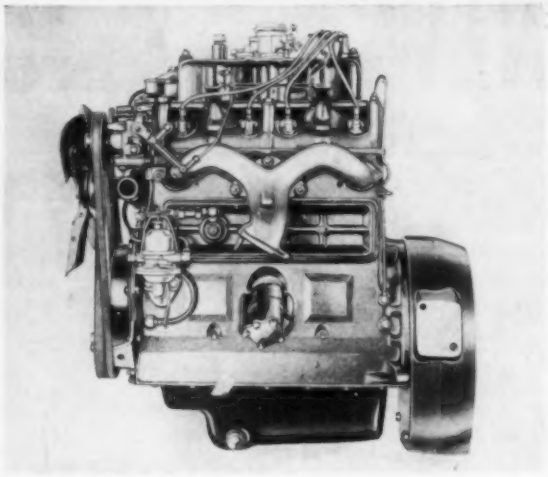
THE BETTER QUALITY...BIGGER VALUE LINE...IN BRASS, STEEL, IRON

CRANE VALVES

CRANE CO., *General Offices:* 836 S. Michigan Ave., Chicago 5, Illinois
Branches and Wholesalers Serving All Industrial Areas

VALVES · FITTINGS · PIPE · PLUMBING · HEATING

Four-Cylinder Industrial Engine

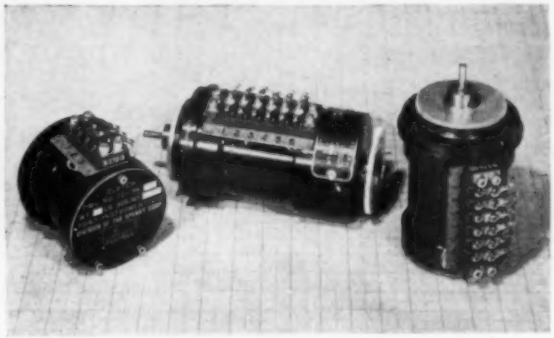


A four-cylinder, F-head gasoline engine for industrial, agricultural, construction and marine equipment is based on designs perfected for the rugged military "Jeep." This lightweight unit has tin-coated, aluminum pistons and automatic crankcase ventilation.

Model 4F has a bore and stroke of $3\frac{1}{8}$ x $4\frac{3}{8}$ in. and the total piston displacement is 134.2 cu in. Maximum brake horsepower at 2,400 rpm is 51 hp and at 4,000 rpm is 70 hp. At the same speeds, maximum torque is correspondingly 111 and 91 ft-lb. Compression ratio on the Model 4F engine is 6.9 or 7.4. Willys Motors, Inc., 1320 N. Cove Blvd., Toledo, Ohio.

For more information—Circle 16, inside back cover

Miniature Magnetic Clutches and Brakes



Magnetic clutching and braking devices for computers and other mechanisms requiring a high order of operative accuracy include units with a single clutch, a double clutch, and a clutch brake (shown in that order, from left to right, in the accompanying illustration).

These units can be energized for indefinite periods. They release immediately upon de-energizing and have a negligible steady-state control current requirement. They are designed with a definite neutral position for the friction disc, precluding dragging on the friction face regardless of mounting position.

Designed to meet military environmental specifications, the units are made with anodized finish, fungus-inert materials, and encapsulated windings. They are constructed of corrosion resistant materials. Operating temperature range is —65 to 165 F.

With the incorporation of a telephone-type relay, maximum response time of all three units is 6 milliseconds or less; without a relay, response time is slightly higher. They are designed for a maximum torque of 16 oz-in., and for intermittent duty at speeds to 1,000 rpm. Overall length (including shaft) of the largest unit, the double clutch, is $4\frac{1}{2}$ in. Weights of the three units are: single clutch 0.8 lb; double clutch, 1.5 lb; clutch brake, 1.2 lb. Electrical requirement is 25 v, dc. Ford Instrument Co., 31-10, Thomson Ave., Long Island City 1, N. Y.

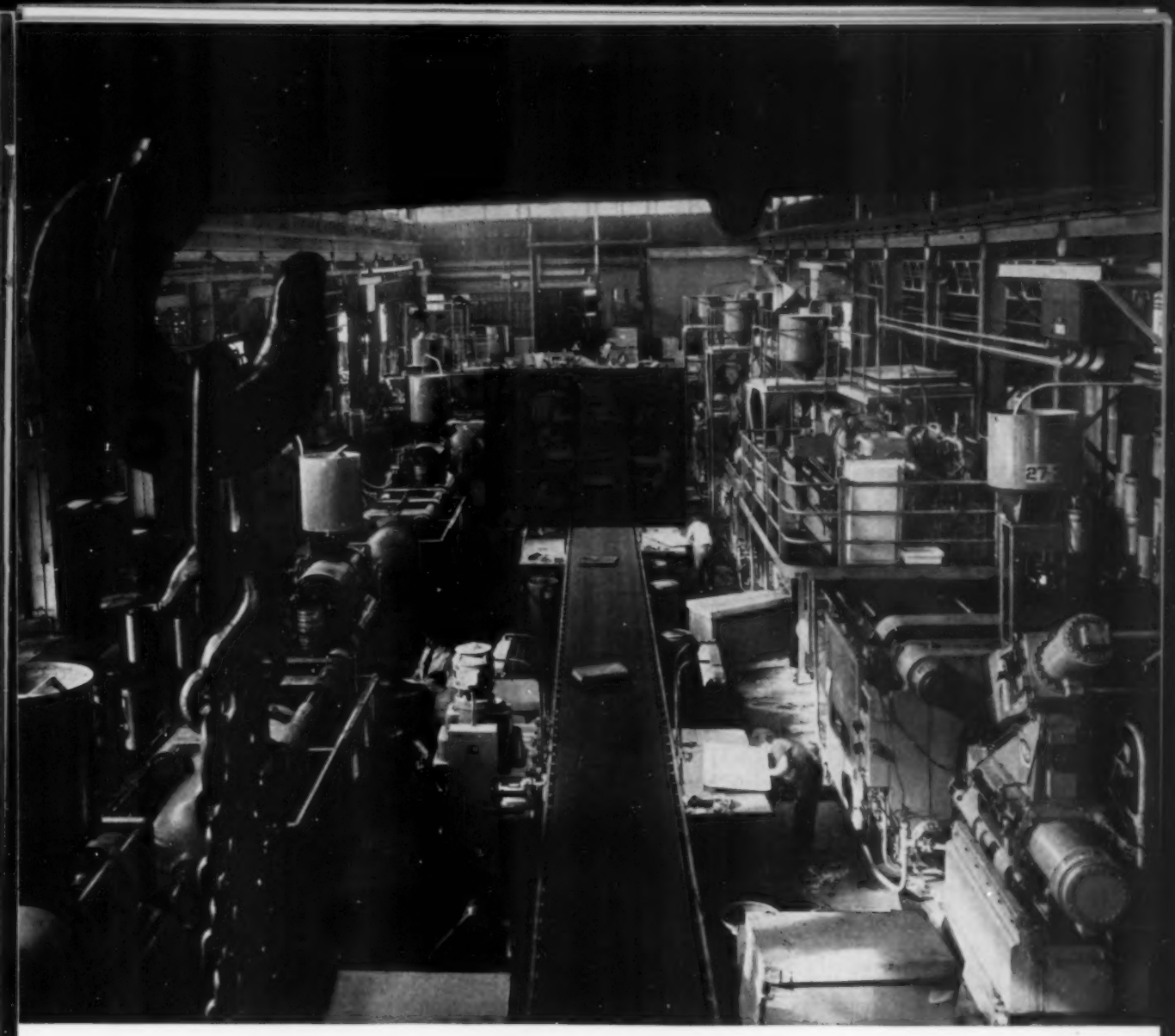
For more information—Circle 17, inside back cover

Aluminum-Coated Steel Wire

Aluminum-coated wire, with reportedly accurate control of both thickness and weight of coating, is intended for applications requiring resistance to corrosive conditions. The coating is said to be bonded tightly to its metal base and is so ductile that it can be drawn to any desired thickness. Based on coatings of equal thickness to that of zinc, resistance to weathering in industrial atmospheres is expected to be 2 to 20 times as long. The product is now available in aluminized seven-wire strand in Siemens-Martin, high strength and utility. Physical properties conform to ASTM specification A-122-52-T for galvanized strand. Aluminum coatings are comparable in thickness to that of Grade A galvanizing. Since physical properties match those of galvanized strand, the same sag tables or charts may be used. American Chain & Cable Co., Inc., 929 Connecticut Ave., Bridgeport 2, Conn.

For more information—Circle 18, inside back cover

CONTINUED ON PAGE 228



new ideas come to life in plastics molded by General American

How many of your good ideas have died on a scratch pad? . . . simply because production wasn't practical.

At General American, manufacturers in many industries have seen their new ideas come to life in plastics. Here on the biggest, most versatile plastics production line anywhere, intricate shapes are molded in one "shot". For many products, volume production in plastics becomes a reality for the first time. Tremendous strength is coupled with light weight. Utility and durability team up with colorful new sales appeal never before possible.

For example, this conveyor belt, serving a double battery of injection presses in one of General American's plants, carries some of the world's largest, most intricate and unusual plastics moldings.

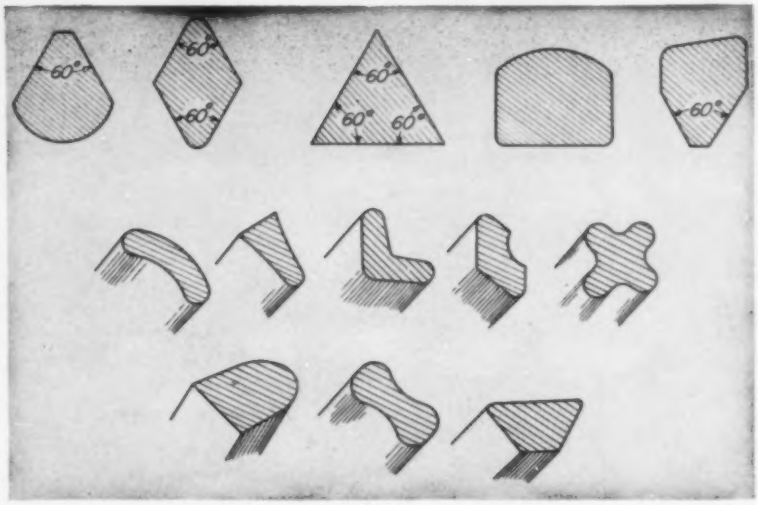
Here—yours to use . . . everything you need from development to delivery. Talk over your ideas *now* with a General American engineer.

PLASTICS DIVISION
GENERAL AMERICAN
TRADE MARK

PLASTICS DIVISION
GENERAL AMERICAN TRANSPORTATION CORPORATION 135 South La Salle Street, Chicago 90, Illinois

● Facilities unmatched anywhere: injection presses to 300 ounces, compression presses to 2,000 tons, reinforced plastics molding, die making, painting, assembly, packaging

Wire of Unusual Cross-Section



This formed wire is available in sizes ranging from a maximum cross-section of 3/16 in. dia down to a minimum of 0.015 in. dia. Tolerances can be held to 0.0002 in. and surface finishes from 8 to 15 micro-inches can be produced. Hardness up to 50 Rc can be obtained in those metals which can be work-hardened.

Wire in several materials can be made. Special wire forms are furnished in lengths on spools, reels or in coils. Helicoil Corp., Danbury, Conn.

For more information—
Circle 19, inside back cover

In-Service Replacement of Critical Valve Parts

For automation or other control set-ups where precise control, long valve life and minimum downtime for parts replacement is critical, the manifold construction of these new valves permits rapid replacement of all critical parts, including the valve body and spool assembly. Neither the piping or the main manifold block have to be disturbed. Electrical valve models also feature a built-in junction box and quick disconnect electrical connections. Solenoid coils can be removed without disturbing the electrical circuit. All electrical leads are channeled from a $\frac{1}{2}$ in. NPT size conduit outlet located at the base of the valve.

These manifold valves are available for air or other non-corrosive gas and oil or water hydraulics. Valve types include 3-way, 4-way, two or three position, in $\frac{1}{8}$, $\frac{1}{4}$, $\frac{3}{8}$, $\frac{1}{2}$ in. (modified) nominal NPT sizes. Actuators include single solenoid, double solenoid (illustrated), piloted, hand lever, fingertip lever, cam roller. Combinations also available.

These valves are designed to exceed the most critical standards. There are no valve packings. Seal is obtained by precision fit. All materials used are corrosion resistant. Beckett-Harcum Co., Wilmington, Ohio

For more information—Circle 20, inside back cover

Flag-Type, Right-Angle Terminals

This is a right-angle, fast-connecting terminal completely solderless for wire sizes No. 18 through No. 12 AWG. It will accommodate the entire range of insulations normally used in automotive and appliance wiring in those sizes. Terminal's tab is reformed with underside to provide reduced section and voidless crimp.

There are serrations on this connector that give increased tensile strength to the connection and improve the corrosion resistance and the temperature performance of this terminal on both clean and corroded wire. This terminal is said to be the only right-angle terminal that can be crimped on a center strip. It will also be possible to feed from either side, using the connector as both a right-handed and a left-handed flag, mating with its tab on a hermetically sealed terminal, or in any other situation where a right or left-handed flag is necessary. These terminals are expected to cost less to apply. Aircraft-Marine Products, 2100 Paxton St., Harrisburg, Pa.

For more information—
Circle 21, inside back cover

the new sealed GUIDEROL® BEARING BY McGILL

Without Increasing Overall Bearing Size this new SG series provides a single and double sealed bearing unit using a standard GUIDEROL bearing and built in commercial lip type seals. This new GUIDEROL bearing unit advantageously replaces ordinary needle type bearings requiring costly auxiliary sealing arrangements.

Installations are simplified and require less bearing space with corresponding savings in machining costs. Housings can be smaller and less complicated for bearings with shaft sizes ranging from ⅜" to 2".

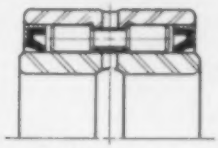
Five different seal combinations provide versatility in handling sealing problems where the proven performance of GUIDEROL bearings can add capacity, dependability and longer life. Using the new complete unit eliminates the bother of separate bearing and seal sources.

Write today for the details on the first sealed unit that offers life-time lubrication for full-type roller bearings.

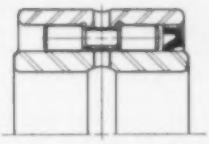
Write today for Bulletin SGR-54 on dimensions, shaft and housing fits and tolerances.

McGill Manufacturing Co., Inc.
201 N. Lafayette Street,
Valparaiso, Indiana

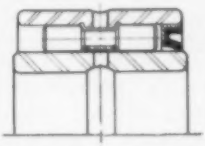
McGILL offers New Sealed GUIDEROL® bearing in 5 seal combinations.



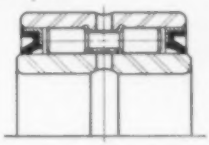
SS—Double seal, lips in. For lifetime retention of lubricant.



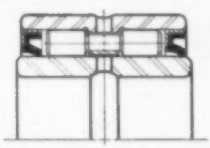
S—Single seal, lip in. Retain lubricant. Usually another sealed bearing at other end of shaft.



RS—Single seal, lip out. Used opposite another bearing to prevent entry of foreign material from one face.



RSS—Double seal, lips out. Prevents entry of foreign materials from both faces.



SRS—Double seal, one lip in, one lip out. For easy relubricating without displacing seal.

McGILL®
precision bearings

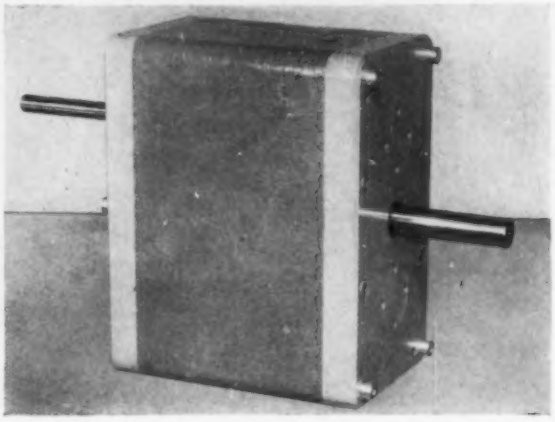
Magnetic Fluid Transmission

A magnetic fluid transmission has been designed to serve as a transmission link between the prime mover and the load in a servo actuator or in any device in which power, compactness and precision control are prerequisites. This unit, in effect, is a variable-torque, selective-rotation transmission employing a pair of magnetic fluid elements.

The two clutch elements are located side-by-side and driven in opposite directions from the input shaft and back-to-back gearing. The output rotors of the clutch elements are interconnected with the output shaft of the unit in a 5-to-1 speed reduction through pinions meshing with a common gear. Other gear ratios can be provided. The direction and magnitude of the transmitted torque depends on which clutch is energized and the amount of d-c current. All components are packaged within a housing assembly and operate in an oil bath for lubrication and improved clutch cooling. Ball bearing and fluid seals give a high-precision, smooth-acting, compact device which measures 14 x 8¾ x 4¾ in. and weighs 37 lb.

The clutch element utilizes a grease-like lubricant in which fine magnetic particles are suspended. The application of a magnetic field from a coil, energized with d-c current, will cause the heavy fluid to stiffen or solidify. The degree of solidifying varies with the amount of d-c current applied to the coil. This current can be obtained from conventional vacuum tubes or suitable rectifiers. The fluid thereby acts as a clutch lining and the varied current produces a varied torque.

This unit employs stationary coils with no slip rings.



Each clutch element is capable of transmitting up to 70 in-lb of torque by energizing its standard 650 ohm coil with 165 milliamperes of d-c current; therefore, 350 in.-lb are available on the output shaft. At the recommended maximum input speed of 650 rpm, the clutch element will transmit 542 w (approximately ¾ hp). Raymond Engineering Lab., Inc., Smith St., Middletown, Conn.

For more information—Circle 22, inside back cover

Engine and Generating Plant

This two cylinder, four-cycle, air-cooled, gasoline-powered engine meets or exceeds all military specifications in design and construction. Of basic aluminum construction, it has been tested and proven in 1,000-hr endurance runs. It is expected that this 21-hp, 140-lb unit will find use powering equipment such as construction machinery, lift trucks, welders, pumps, compressors and refrigeration units.

Suction cooling of the engine by a large centrifugal blower collects the hot air and discharges it through a single outlet, permitting satisfactory performance in a small compartment. The engine will deliver a maximum of 19 hp, with accessories, at 3,600 rpm, assuring adequate power for scores of heavy-duty applications that require from 10 to 15 hp (continuous). Basically equipped for manual starting, engine can be provided with electric starting.

The 5,000 w electric generating plant powered by the new engine supplies multiple voltages (1 and 3-phase), with voltage regulation within 4 percent. A single rotary switch selects the required voltage and phase. The generator has an actual dry weight of 445 lb and is said to require 25 percent less space than other sets. A mounted tank provides sufficient fuel for 5 hr of operation at full-rated load. A fuel supply hose and selector valve permits connection to an auxiliary fuel supply.

Rated at 5 kw with 60-cycle output, Model 5VB-4M is

also available with d-c output up to 7½ kw in standard voltages. The generator is designed and tested in accordance with MIL-G-10228 (CE). D. W. Onan & Sons, Inc., Minneapolis 14, Minn.

For more information—Circle 23, inside back cover

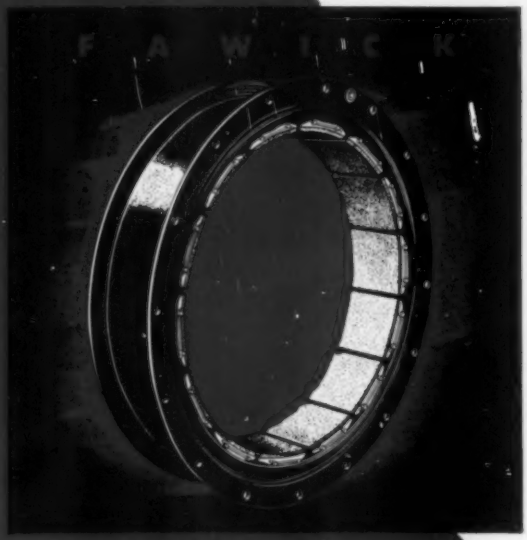
CONTINUED ON PAGE 232

...BARGAIN HUNTING?

FAWICK AIRFLEX CLUTCHES AND BRAKES WILL GIVE YOU (1) IMPROVED MACHINE PERFORMANCE, (2) EXTRA SAFETY FACTORS, and (3) LOWEST LIFETIME COST!

● You will find, like thousands of operators, that FAWICK Airflex CLUTCHES and BRAKES are the best investment you can make on your machines. Your first profit return will be the improved performance (and increased production) of your FAWICK-equipped machine—with fast, smooth, and shock-free operation, plus overload protection for both men and equipment. You will also find that simple, rugged FAWICK units practically eliminate maintenance costs as they require no lubrication and are self-adjusting to insure continuous "new clutch" operation. When you total all the advantages of FAWICK units on new or "converted-to-efficiency" machines, you will find, as have present FAWICK users, that the best answer to this particular power-transmission problem is FAWICK Airflex—the name that insures peak clutch and brake performance.

The performance-proved FAWICK TYPE CB Airflex CLUTCH.



SMOOTH SHOCK-FREE ACTION
MAXIMUM OVERLOAD PROTECTION
SPLIT-SECOND CONTROL
LONG MAINTENANCE-FREE LIFE

FAWICK AIRFLEX DIVISION
FEDERAL FAWICK CORPORATION
9919 CLINTON ROAD • CLEVELAND 11, OHIO

For further information on Fawick Industrial Clutch and Brake Units, write to the Main Office, Cleveland, Ohio for Bulletin 400-A.

FAWICK Airflex
INDUSTRIAL CLUTCHES AND BRAKES

Insert Locks Screws In Place

Called a "grip-end" insert, this one-piece screw thread can easily be incorporated into an otherwise frozen design, because it requires no more boss material or wall thickness than a conventional tapped thread. It is now in successful use by a leading aircraft company for cowl fasteners and is being actively considered by other such manufacturers for airframe assemblies. Other possible applications include power tools, air hammers and other equipment subject to vibration, temperature extremes, periodic inspection teardown or frequent interchanging of attachments.

The insert is made of precision-formed stainless steel wire that seats itself springlike in a hole to provide 60-deg threads. A constricting area in the bottom-most coil gripping the screw applies torque which meets the requirements of AN-N5B for lock nuts. The locked screw may readily be freed by applying breakaway torque approximately the same as the torque used in making the original assembly. The same high on-and-off torque is retained through many cycles.

Because screws used with these inserts need not carry locknuts, they may be shortened correspondingly. The elimination of nuts and reduction of lengths make it possible to cut the weight and cost of an assembly.

The new insert is immediately available in sizes 10-32 and 1/4-28 in two standard lengths. Other sizes of these inserts are now being developed. Helicoil Corp., Danbury, Conn.

For more information—Circle 24, inside back cover

Miniature Motor and Generator In Same Housing

This miniature a-c, motor-driven induction generator combines an induction motor having a high torque-to-inertia ratio with a linear drag cup generator. It is designed to simplify the problem of coupling motor and generator by providing positive alignment in a single housing machined to close tolerances. The generator contains a two-phase winding. When one phase is excited the other phase develops an output voltage proportional to the speed. Frequency is the same as that used to excite the unit. Linearity is dependent on the voltage output desired and range of operating speeds.

Input (motor stalled) is 7.4 w. Torque (stalled) is 0.8 oz-in. Voltage output of second phase is 3.5, ± 0.6 v per 1,000 rpm. No-load speed is 3,070 rpm, counterclockwise. Reversing time is 0.06 sec. Weight 15.4 oz. Electric Indicator Co., Springdale, Connecticut.

For more information—Circle 25, inside back cover

Color-Coded Wire Meets Specifications

These spirally striped, Teflon-insulated hook-up wires for color coding and circuit identification are said to be the first produced conforming to prevailing specifications.

The colored stripes are made with high temperature tetrafluoroethylene inks fused into the surface of the insulation. A broad colored helical stripe is used on natural or white insulation to represent the base color. One or two narrower stripes can represent conventional tracer colors.

A total of 819 different combinations are possible using black, brown, red, orange, yellow, green, blue, purple and grey inks on neutral or white insulation. Finished wire is supplied in conductor sizes from No. 26 to No. 10 AWG. The teflon insulation has a nominal wall thickness of 0.010 in. to meet the requirements of MIL-W-16878A specification for Type E wire, rated for operation at 600 v up to 250 C continuous temperature. Wire is also available with wall construction of 0.007 in. wall thickness. Tensolite Insulated Wire Co., Inc., 196 Main St., Tarrytown, N. Y.

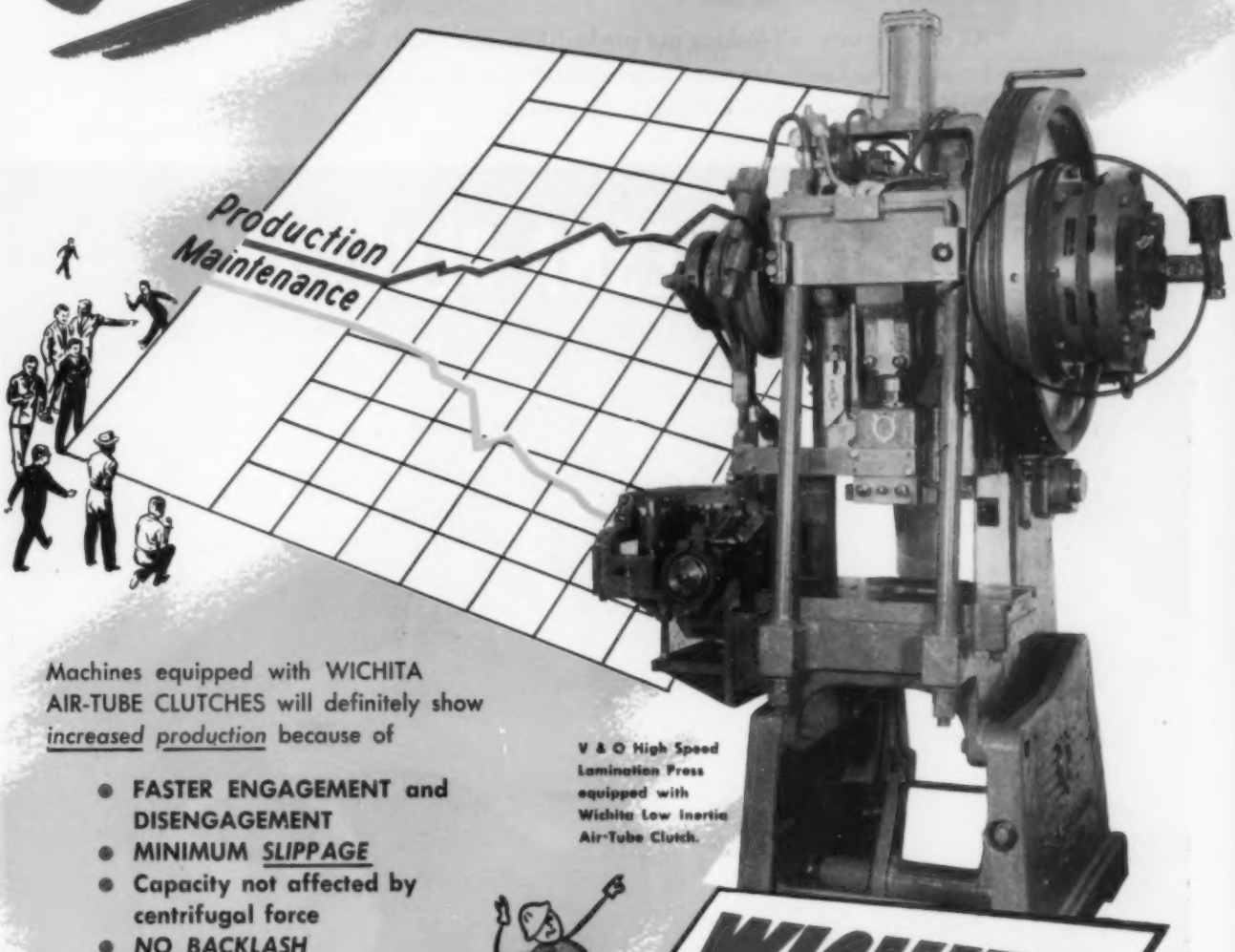
For more information—Circle 26, inside back cover

CONTINUED ON PAGE 238

INCREASE PRODUCTION

Immediately

WITH WICHITA *Air-Tube* CLUTCHES



V & O High Speed Lamination Press equipped with Wichita Low Inertia Air-Tube Clutch.

Machines equipped with WICHITA AIR-TUBE CLUTCHES will definitely show *increased production* because of

- **FASTER ENGAGEMENT and DISENGAGEMENT**
- **MINIMUM *SLIPPAGE***
- **Capacity not affected by centrifugal force**
- ***NO BACKLASH***
- **Complete safety**
- ***LESS DOWNTIME***
- **Simple, Efficient Design**
- **Longer Life**
- **Very LOW MOMENT of INERTIA**

WICHITA
FOUNDRY & MACHINE CO., INC.
WICHITA FALLS, TEXAS, U.S.A.

Wichita Clutches have been *job proven* on many types of machines and not one has been removed! So to Increase Production see your nearest Wichita Engineer. He has detailed information on all Wichita Clutches.

WICHITA DISTRIBUTORS
Brehm-Lahner, Inc., Detroit, Michigan
L. H. Fremont, Cincinnati, Ohio
W. G. Kerr Company, Pittsburgh, Pa.
Smith-Keser & Co., (Main Office) West Hartford, Conn.
Smith-Keser & Co., Philadelphia 44, Pa.
Smith-Keser & Co., New York, N. Y.
Frank W. Yerline Co., Chicago, Ill.
Power Rig & Equipment Co., Inc., Long Beach, Calif.
Robert R. King Co., Cleveland, Ohio
John C. Burge, Oklahoma City, Oklahoma
Dominion Power Press & Equipment Ltd., Toronto, Canada

ESNA's new lightweight product lines

Design specifications on these complete lightweight lines now available

All of these new self-locking nut product lines have been approved for use on Air Force, Army and Navy aircraft. Look them over—decide how much these weight reductions can mean to you.

Save 115 lbs. per bomber — On a bomber the size of a B-52 ESNA Blue "J's" applied to steel bolts and used in place of AN steel self-locking nuts would eliminate 115 lbs. of fastener weight without sacrificing strength! Lubricated to minimize thread wear and galling. Hex nuts are offered with fiber or nylon locking inserts while anchor and channel types of "fixed" nuts are provided exclusively with nylon to permit extended reusability. *Completely interchangeable* with similar steel parts. Available in #6 through ¼" sizes . . . in every important hex and "fixed" nut configuration including floating basket nuts and straight and curved gang channel.

ESNA Type Y
Weight saving—¼—28 size=.36 lb/100 pieces.
40%* lighter!

For ¼" sizes and above—Here is the new ESNA "12-point" nut, a steel part that meets AN365 tensile requirements with significant weight savings in sizes of ¼" and above. Double hex shape permits design improvements and easier installation for locations where wrenching clearance is limited.

ESNA Type NA401
Weight saving—10/32 size=.51 lb/100 pieces.
51%* lighter!

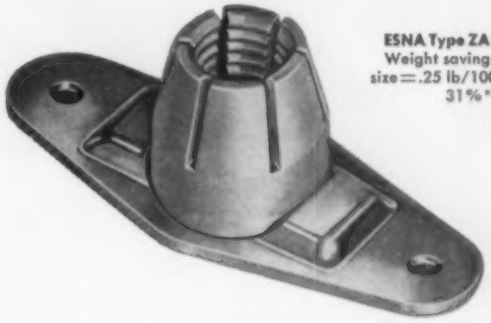
ESNA Type NAJ401
Weight saving—10/32 size=.64 lb/100 pieces.
64%* lighter!

ESNA Type 12LHA401
Weight saving—10/32 size=.41 lb/100 pieces.
41%* lighter!

"Floaters"—When production methods result in the minor subassembly misalignments that make floating type nuts desirable, look to ESNA for lighter, stronger parts. Pictured are ESNA's newly designed steel floater and floaters from the aluminum Blue "J" and high temperature LH lines. Conforming to AN366 dimensions, better performance and lower weight have been accomplished without sacrificing tensile strength.

ESNA Type LHA1
Weight saving—10/32 size=.39 lb/100 pieces.
56%* lighter!

For temperatures to 550° F—ESNA's new LH lines are lighter high-temperature anchor nuts with a completely new locking device offering performance that meets Spec AN-N-10 and providing extended reusability. Approval has been issued for sizes #6, 8, 10 and ¼". Also available in one lug, corner, two lug floating basket and gang channel types.



ESNA Type ZA1W1200
Weight saving—10/32 size=.25 lb/100 pieces.
31%* lighter!

Easier welding of fixed fasteners—Here is a lighter stainless steel anchor nut to be used for temperatures up to 1200° F. Available with rivet holes or welding nibs. Unplated base plate of Type 321 stainless makes it particularly suitable for attachment by welding. A second nut, designed for temperatures up to 800° F. to meet AN362C requisites, is also available.

With these new parts, you can save weight on virtually all aircraft self-locking nut applications. Mail our coupon for design specifications.

Elastic Stop Nut Corporation of America

*These are typical weight savings compared with earlier ESNA designs for the same applications.

Dept. N63-92, Elastic Stop Nut Corporation of America
2330 Vauxhall Road, Union, N. J.

Please send me the following free fastening information:

☐ Product literature, samples of the following types:_____

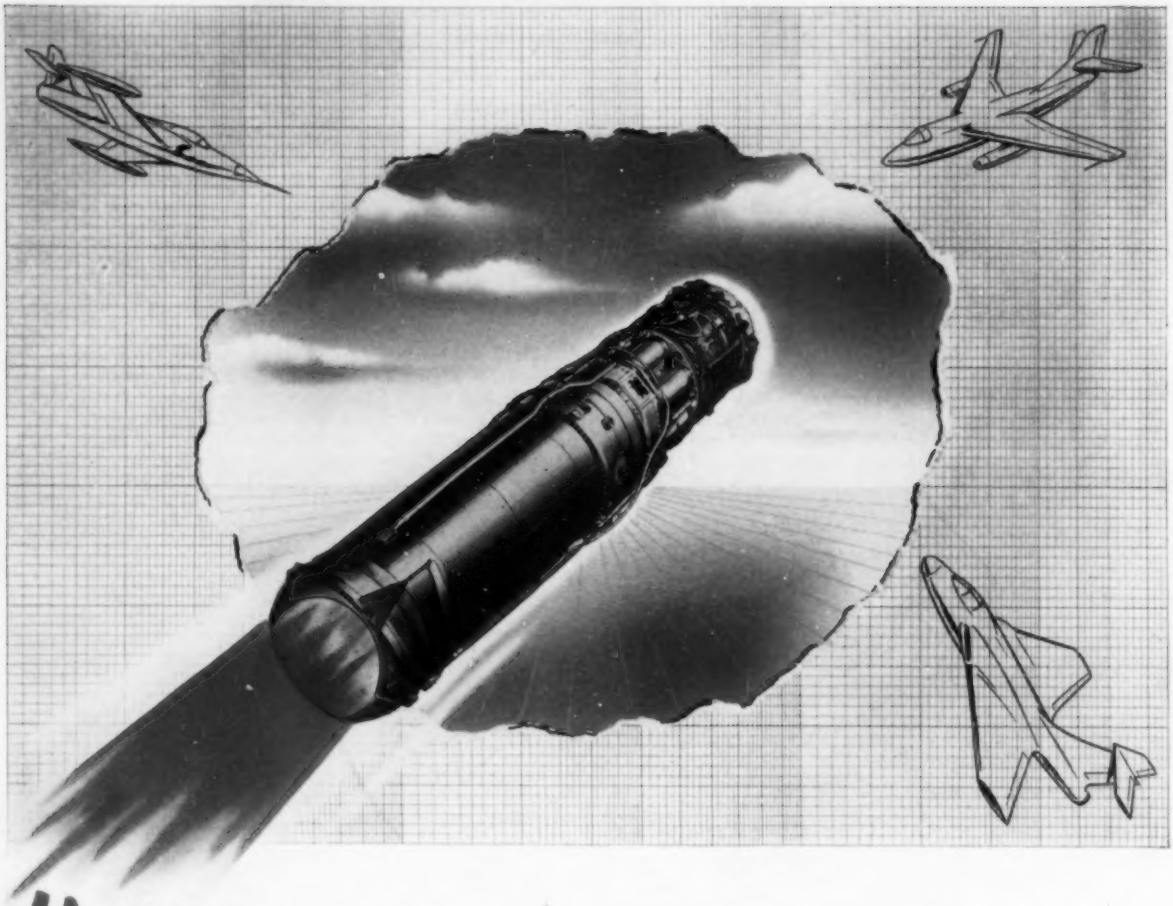
☐ Please have an ESNA application engineer get in touch with me.

Name_____ Title_____

Firm_____

Street_____

City_____ Zone____ State_____



Hotter "Hot end" components

Jet engine performance is measured in terms of "specifics". "Specific thrust" is pounds of thrust per pound of air per second. "Specific weight" is pounds of engine weight per pound of thrust. The goal is always more and more thrust for less and less weight.

In this quest, the ability to produce higher "specific thrusts" at lower "specific weights" depends on the ability to handle ever-increasing temperatures, and is therefore a direct measure of the success of new designs. To this end, the ingenuity of engineers and metallurgists is constantly taxed to achieve durability at higher temperatures through better design and better materials.

Jet engine "hot end" components and other complex fabricating problems are not new to I-T-E's Special Products Division. Its engineers and production men have specialized in solving the problems involved in tooling for and producing "hot end" components of hard-to-work alloys in complex designs.

Perhaps these men can help you with your problems.

Why not send for Publication SP-100 P-9 today. It shows what has been done to help others.

RADAR ANTENNA SYSTEMS
design, development and fabrication

JET ENGINES
manufacture of major hot-end components

THERMODYNAMICS
design, development and fabrication of equipment to operate on advanced theories

GUIDED MISSILES
advanced fabricating techniques

TITANIUM
proven welding, forging, forming, spinning techniques with this hard-to-work metal

SPINNING
combining spinning and drawing to an almost limitless variety of designs in a wide range of metals

TECHNOLOGY
ABILITY
FACILITIES

SPECIAL PRODUCTS DIVISION
I-T-E CIRCUIT BREAKER COMPANY
601 East Erie Avenue • Philadelphia 34, Pa.
Progress through Problem Solutions SP 10.5

DESIGN and PRODUCTION NEWS

FOR PLASTICS AND MATERIALS ENGINEERS

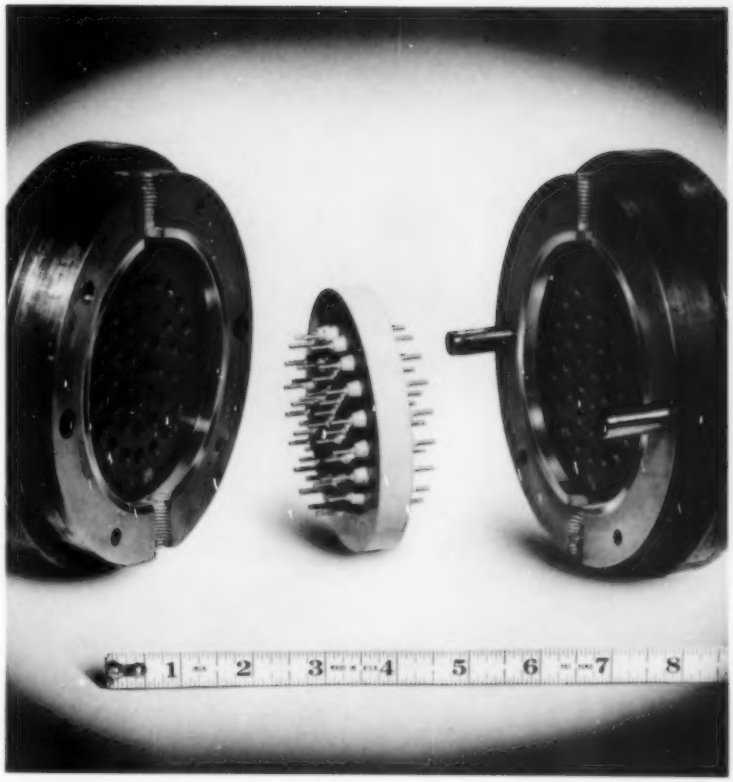
Published by TECHNICAL SERVICE, Chemical Manufacturing Division, The M. W. KELLOGG Company AUG.-SEPT. 1954

Casting Molds of KEL-F® Polymer Replace Plated Metal Molds... Cut Costs, Finishing and Rejects!

Complex electrical terminal boards, made of an especially abrasive epoxy compound, are now cast in molds of KEL-F polymer, replacing former metal molds. Advantages include lower original mold costs, lower maintenance costs, fewer rejects and higher product precision without extensive machining.

Excellent wear characteristics of the new molds result in longer mold life despite high silica content of the casting resin. The non-hesive properties of KEL-F polymer prevent pitting by the resin, result in damage-free release of the product without special coatings. Penn-Plastics Manufacturing Company, Glenside, Pa., produce these intricate new molds by transfer methods. Molded of KEL-F polymer Grade 300, they are designed to hold 40 terminal pins and to impress forty 1/16" numerals in both faces of the finished part. Terminal boards are manufactured by Penn-Plastics in conjunction with Woodmont Products, Inc., electronic parts manufacturers of Huntingdon Valley, Pa.

For further information ask for Application Report P-101



New Bearings of KEL-F® Polymer Eliminate Shaft Seizing... Need No Lubrication!

Shaft seizing is stopped and lubrication is eliminated when rotating metal plating racks are equipped with end bearings of KEL-F polymer. Chemically inert, the tough plastic bearings are unaffected by the most corrosive cleaning and plating solutions...allow smooth rotation. Bearing "drag" is low because the fluorocarbon is dimensionally stable. It will not swell or shrink in contact with water, steam or chemical vapors.

Kurz-Kasch, Inc., plastic molders of Dayton, Ohio, compression-mold the two-piece bearings from KEL-F polymer Grade 300 for use in plating equipment manufactured by The Stolle Corporation, Cincinnati, Ohio.

For further information ask for Application Report C-117

(SEE REVERSE SIDE)

® *Registered trade-mark for The M. W. Kellogg Company's fluorocarbon Polymers.*

CONTINUED FROM PRECEDING PAGE

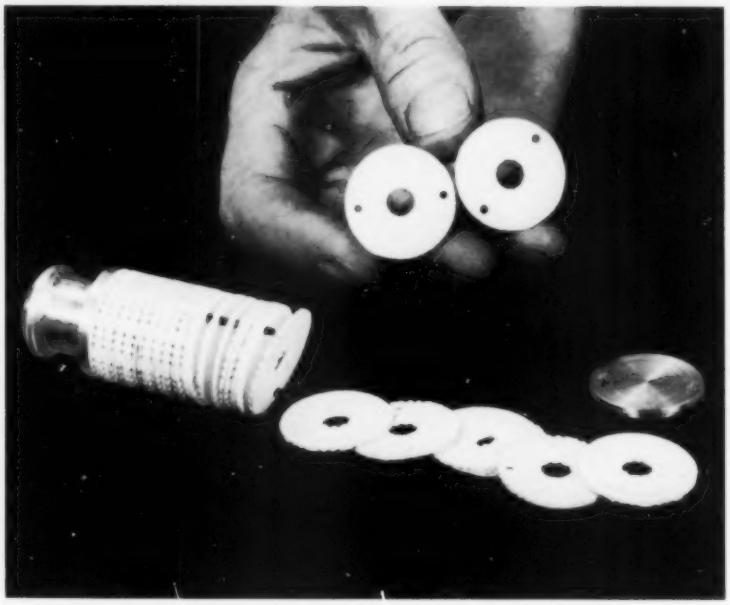
New Aircraft Fuel and Oil Filter Uses Porous KEL-F® Plastic . . . Gains Increased Efficiency, Longer Service Life

High strength in contact with corrosive aircraft oils and fuels at elevated temperatures, high filtering efficiency and simple field maintenance make this a superior filter.

Consisting of a "stack" of discs molded of KEL-F polymer, the porous plastic withstands pressure surges and thermal cycling without rupturing. Corrosives such as fuming nitric acid, hydrogen peroxide and hydraulic and lubricating oils are handled by the chemically-inert porous plastic. Throughput is increased simply by adding on more disc combinations.

The unique filters are manufactured by Aircraft Porous Media, Inc., Glen Cove, N. Y., and employ discs molded of KEL-F polymer Grade 300 by the Porous Plastic Filter Company, also of Glen Cove, N. Y.

For further information ask for Application Report C-11B



Molders & Fabricators of the Month

Leading molders, extruders and fabricators specialize in the production of materials and parts made of "Kel-F" . . . each month this column will spotlight several of these companies with their principal services and products.

Consolidated Molded Products Corp.
Scranton, Pa.
Compression & transfer molding
Injection molding

Cortland Industries, Inc.
Chicago, Ill.
Sealing of film
Production machining

General Plastics Corporation
Paterson, N. J.
Dispersion Coating

United States Gasket Company
Camden, N. J.
Extrusion
Forming & machining
Injection, compression & transfer molding
Rod, tube and sheet; tube sockets
Gaskets, gauge glasses & tower packing

The William Brand and Company, Inc.
Willimantic, Conn.
Insulated wire

Recent Significant KEL-F Polymer Developments . . .

Pyrex-to-steel seal is effected in a new centrifugal pump with a resilient O ring of KEL-F plastic. Damage to the glass observation plate, leaks at high pressures have been eliminated.

Electronic tubes used at high altitudes are now hermetically sealed in new sockets made of fluorocarbon plastic. Consistent hermetic seal over a wide temperature range, low "arc-over" and shock damage are major features.

Conductivity cell-valve units for testing potable water use KEL-F polymer as a structural and electrical insulating member. Immersed continuously in water at temperatures up to 250°F, machined insulator maintains critical electrode gap.

Pump vanes of molded glass-filled polymer have been found to have the necessary strength as well as complete chemical inertness to stand up under hot, extremely corrosive chemicals in a new transfer pump.

OFF THE PRESS . . .
Revised "BUYERS GUIDE" listing KEL-F polymer products, molders and fabricators.

For complete information regarding any item mentioned in DESIGN AND PRODUCTION NEWS, ask for detailed APPLICATION REPORTS, write

Technical Service
CHEMICAL MANUFACTURING DIVISION
THE M. W. KELLOGG COMPANY
P. O. Box 469, Jersey City 3, N. J.
or offices in Boston, Chicago, Dayton, Los Angeles and New York

M W KELLOGG PULLMAN

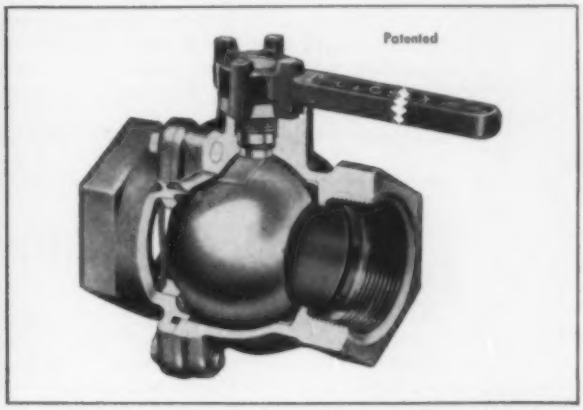
® *Registered trade-mark for The M. W. Kellogg Company's fluorocarbon Polymers.*

Do you need a QUICK ACTION VALVE?

Quick Action on Fishing Boats. Because of the quick opening and closing of Rockwood Ball Valves, fishing boats can make a swift change-over from pumping out boats to supplying wash water for decks.

Quick Action in a Propane Plant. The Rockwood Ball Valves in this propane plant are opened and closed every two minutes during the day. They need only ¼ turn even under full pressure.

Quick Action in a Steel Plant. Rockwood Ball Valves were selected by this large steel corporation primarily for their quick turn on and off action and leakproof service. They permit careful control of oxygen flow to open hearth furnaces.



Quick Action for Continuous Trouble-Free Performance. The quick opening and closing action of Rockwood Ball Valves is a welcome feature in many different applications. You can depend on them for reliable, day-in, day-out service.

Note these other exclusive features!

Full Round Flow — assuring fast, efficient operation, less friction loss.

Leakproof — in closed position, pressure of fluid automatically positions ball against synthetic rubber seat to form a tight seal.

Resists Wear Longer — Chrome-plated bronze ball stands up under abrasion, pitting and scratching.

From alcohol to asphalt, from petroleum to pickling acids, Rockwood Ball Valves perform with trouble-free continuity. Longer time between replacements, less maintenance on the job. Comes in all pipe sizes. Tested and listed by Underwriters' Laboratories, Inc. The coupon will bring you complete information.

ROCKWOOD

THE FLOW IS AS ROUND AS THE PIPE ITSELF

***FULL-FLOW* BALL VALVES**

ROCKWOOD

ROCKWOOD SPRINKLER COMPANY
609 Harlow Street
Worcester 5, Mass.

Send me illustrated folder V-4 on Rockwood Full-Flow Ball Valves.

Name.....

Title.....

Company.....

City.....

Zone.....State.....

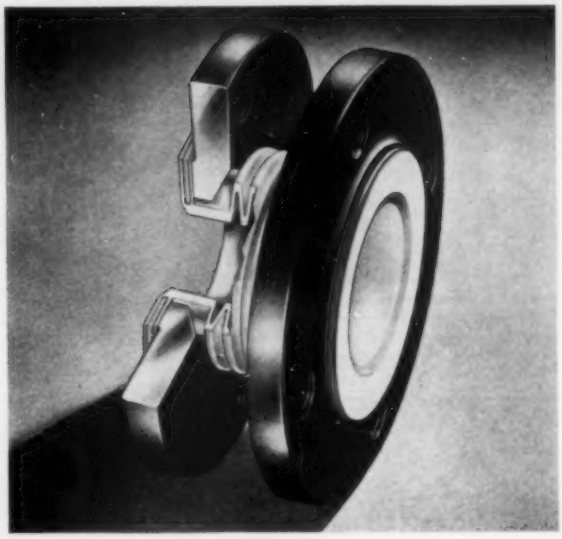
Bellows with Standard Flanges

Chemically inert, corrosion and heat resistant bellows made of Teflon are now available with companion flanges conforming to standard American bolt hole circles and numbers for pressures up to 125 psi. Typical applications include vibration dampers, expansion joints and connectors. They are available in a wide range of designs suitable for metering pumps, pressure accumulators, batching scales, hydraulic systems and others.

These bellows can be supplied to fit any pipe size from ½ through 12 in. A new convolution is employed which is said to give greater strength, longer life and increased flexibility. Since they retain formation at full free length, they are subjected to minimum residual and working strain. They expand and contract in either direction with equal freedom of motion. Operating temperature range is from —94 to 500 F.

Bellow flanges are of a French-type gasket construction to provide more efficient sealing at lower flange pressure. The gasket insert material used in this new component is asbestos or synthetic rubber. Crane Packing Co., Dept. PEN, 1800 Cuyler Ave., Chicago 13, Ill.

For more information—Circle 27, inside back cover



Fluctuating-Pressure Transducer

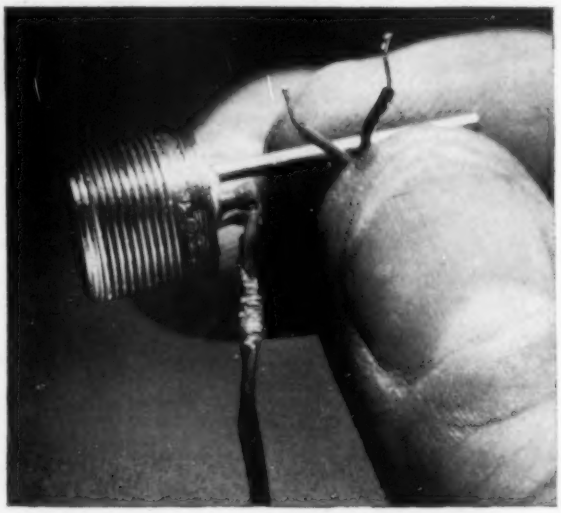
In the re-design of these bonded strain-gage transducers, the reference pressure tube has been brought out through the rear together with the electrical terminals, permitting the unit to be threaded into its flush-mounting position from either direction. This miniature, light-weight (4.5 G) model has been used since its introduction in 1946.

Having their sensing diaphragm flush with the surface against which pressure is to be measured, a resistance change is provided which is a true representation of pressure change.

Structurally, the transducer is a hollow threaded cylinder with a taut diaphragm at one end, and the electrical and reference pressure connections at the other. A 120-ohm strain gage is bonded to the inner surface of the diaphragm.

Standard units are ½ in. dia available in two lengths: ¼ and ⅜-in. Seven pressure ratings are supplied as follows: 2½, 5, 10, 25, 50, 100 and 200 psi. Linearity is 2 percent; operating temperature range, —40 to 250 F; acceleration effect, 0.02 percent per G; resonant frequency of the diaphragm, 8,000 cps. Electronic Engineering Associates, Ltd., 1082 Brittan Ave., San Carlos, Calif.

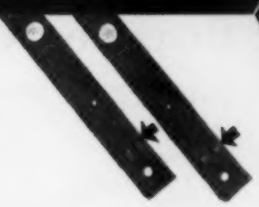
For more information—Circle 28, inside back cover



A NEW HIGH TEMPERATURE TRANSPARENT RESIN called HT-CR-39, is reported to have strong impact resistance and to withstand short-duration exposure to temperatures as high as 350 F with no loss of clarity or rigidity. This material, a copolymer of allyl diglycol carbonate and triallylcyanurate, is also claimed to possess outstanding resistance to abrasion, hot metallic spatter and all types of chemical fumes and solvents. Available in sheet form in standard thicknesses up to ½ in., this material is intended for flat glazing applications and cannot be hot-formed. Cockpit windows in open hearth charging machines are of this material. Cast Optics Corp., 1010 Post Road, Riverside, Conn.

For more information—Circle 29, inside back cover

CONTINUED ON PAGE 240



CROSSBAR CONTACTS FOR MINIATURE RELAYS

Originally designed for use in telephone relays, crossbar contacts are now widely used for miniature relays and contacts. Assembly is speeded and eased because alignment of contacts is not critical.

Major savings are made by attaching with Makepeace machines which cut off and weld automatically, and in the reduction of waste of precious metal. Laminated precious metal capped contact tape is produced in production runs and supplied on reels. There is no handling of individual tips.

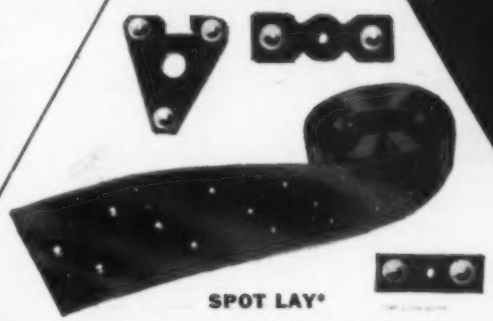
Better Electrical Contacts by

Makepeace

For more than half a century, Makepeace has specialized in and perfected the production of laminated and solid precious metals. Tolerances are held to the closest possible margin. Electrical qualities, strength, hardness and temper meet the most exacting specifications. As a result, manufacturers of electrical equipment look to Makepeace as their most dependable source of supply for materials of the highest quality and the longest service life.

RAISED LAY

When raised lay is used, costly assembly operations are reduced to blanking costs and no precious metals are wasted. That is because one or more strips of silver are bonded to a base metal in the form of a ridge or a bar. Cold, hard rolling produces the required temper in the base metal and dense hard contact surfaces for the most efficient electrical and mechanical qualities.



SPOT LAY*

Developed and perfected by Makepeace, this exclusive process brazes slugs of precious metal in strip stock, positioning them exactly where needed. This new, economical and efficient material permits manufacturers to produce rotors in switches and small bridge contacts at lower costs and with improved life performance.

*Patented

PRECISION RECTANGULAR WAVEGUIDE TUBING
MICROWAVE COMPONENTS • MICROWAVE TRANSMISSION ASSEMBLIES • ELECTRICAL CONTACT MATERIAL • FORMED ELECTRICAL CONTACTS
CROSSBAR WELDED CONTACTS • SLIP RING AND SLIP RING ASSEMBLIES • BRUSH ASSEMBLIES
PRECIOUS METALS CLAD TO BASE METALS
SHEET—TUBING—WIRE AND ASSEMBLIES
SENDZIMIR PRECISION ROLLING

D. E. MAKEPEACE COMPANY
Division of Union Plate and Wire Co.
Attleboro, Mass.
Sales Offices: New York • Chicago • Los Angeles • Columbus

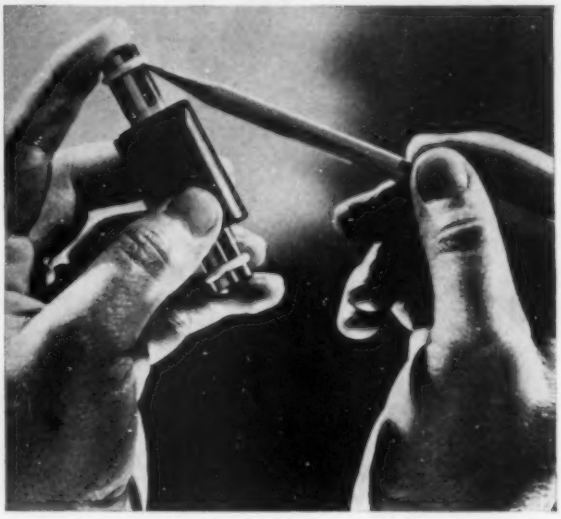
Plastic Ring Lowers Shaft Retention Costs

Potential users of this plastic retaining ring include the automotive, aircraft, electrical, business machine and toy industries. It is reported to provide greater retaining power at lower cost and can frequently be substituted for such articles as cotter pins, nuts, split rings, snap rings, some cotter keys, bent and coiled wires, plain or tapered pins and other fastening devices used in holding two or more parts together, relative to one another.

This elastic ring is slipped over the pin post, axle or shaft and seated in a groove. Because of its contractile characteristics, it will hold securely. Threads, holes, slots are sometimes eliminated. The required groove, which can frequently be formed during the turning operation just prior to cut-off, must have a radius of over 50 percent of the cross-sectional area of the ring, so that slightly over half of the retainer falls below the surface of the shaft. For example, the groove radius for a $\frac{3}{8}$ in. ring of 0.070 in. section dia. is 0.040 in. When force is exerted, the Plasti-Ring tends to imbed itself more firmly in the groove; its upper portion projects sufficiently to act as a thrust bearing, thus providing secure retention of any member on the shaft.

These new rings are injection molded of oil-and-grease-resistant elastic vinyl, which resists the action of most chemicals, alkaline or acid, and consequently can be used in a wide range of applications where chemical resistance is an important factor.

The elastic characteristics of these rings permit repeated application without deformation and with continued high retention powers on the shaft. They will withstand temperatures up to 180 F, even in continuous operation, without losing any of their inherent elastic properties.



The new retaining ring is being produced in 16 basic sizes, $\frac{1}{8}$ through 1 in. shaft sizes. It will be furnished in white vinyl for easy identification, with or without a removal tab as required in the particular application. Illinois Tool Works, 2501 North Keeler Ave., Chicago 39, Ill.

For more information—Circle 30, inside back cover

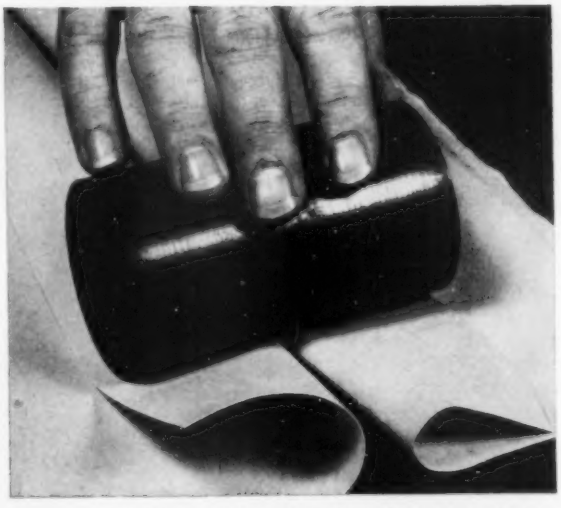
Silicone Coating Raises Crease Resistance

An improved silicone rubber coating for glass cloth or synthetic fabrics has been developed by Dow Corning Corporation. Retaining the name, price and basic properties of the compound it replaces, an improved silicone rubber coating provides increased crease resistance and excellent retention of dielectric strength.

Sample 10 mil coatings on heat-cleaned glass cloth, for instance, keep their original average tensile strength, lengthwise, of 140 psi after four creases. Crosswise tensile strength averages 135 psi uncreased, 130 psi after four creases. After aging 96 hr at 200 C the lengthwise average is 145 psi, uncreased; 95 psi after four creases.

Similarly coated samples, measured with $\frac{1}{4}$ in. electrodes, exhibit a dielectric strength of 1100 v per mil both "as received" and after 21 days at 250 C. Properly coated cloth readily meets the requirements for use in products such as shipboard cable tape.

Less sensitive to processing temperatures than comparable silicone rubbers, the new coating cures equally well over a wide range of tower temperatures, as used in typical production operations. It is commercially available in the form of 100 percent solids or as a 35 percent dispersion in xylene. Dow Corning Corp., Midland, Mich.



For more information—Circle 31, inside back cover

—CONTINUED ON PAGE 242

Beautiful? YES—THEY'RE STAINLESS STEEL
Expensive? NO—THEY'LL LAST FOREVER!

Allegheny Metal *lasts!* As far as anyone knows, it won't wear out, and it can't wear off because it's solid . . . the same bright, hard, immensely strong metal all the way through. No other metal can match stainless steel in this combination of desirable qualities. So, whether you're thinking about pots and pans, or anything from safety pins up to railroad trains and skyscrapers—remember that Allegheny Metal costs less in the long run because it *lasts* longer, and because it stays beautiful for life with little or no maintenance. ● Let us help *you* use it. ***Allegheny Ludlum Steel Corporation, Oliver Bldg., Pittsburgh 22, Pa.***

FOR FURTHER INFORMATION
SEE OUR CATALOG IN SWEET'S
PRODUCT DESIGN or PLANT ENGINEERING or ARCHITECTURAL FILES
. . . or write us for literature.

You can make it BETTER with
Allegheny Metal

AL® TIME-TESTED STAINLESS STEEL

Warehouse stocks carried by all Ryerson steel plants

WAD 8217B

Spindles and Slides for Special Machines

A line of standard slide assemblies and another of standard spindles can both be used to simplify the design and manufacturing of special production equipment.

In the case of the spindles, certain types can be shipped from stock—on other types, delivery will not exceed 90 days.

Drills, reamers, taps, end mills and other tools of similar size can be accommodated. Spindle sockets are furnished for either a No. 0 or No. 1 taper shank, or $\frac{1}{8}$, $\frac{5}{16}$ or $\frac{1}{2}$ in. max capacity collets. Overall dimensions of the spindle assemblies run from $4\frac{5}{8}$ to 8 in. length and from $1\frac{5}{8}$ to $2\frac{1}{2}$ in. dia.

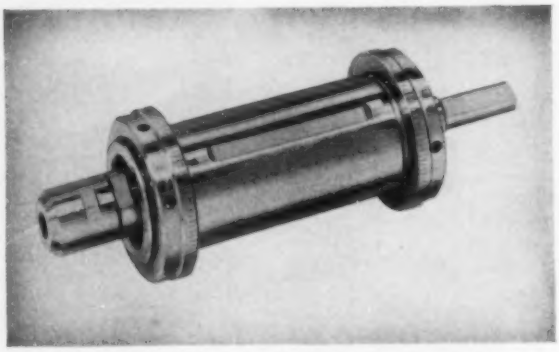
Longitudinal (in-and-out) adjustment of the spindle with relation to its mounting surface is provided by means of nuts at either end of the quill housing. These adjusting nuts are graduated in increments of 0.0005 in. on all models and sizes except the $\frac{1}{8}$ in. collet-type spindle, which has nuts graduated in increments of 0.001 in.

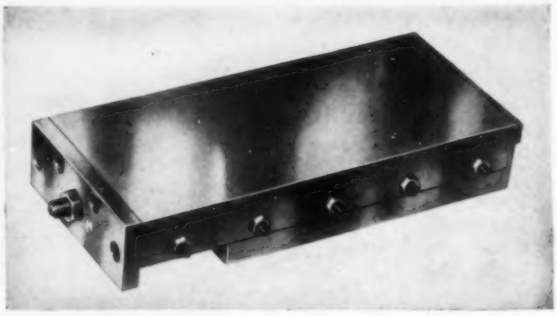
These spindles are precision machined from tool steel, then hardened and ground. Single-row ball bearings at either end of the assembly are standard, but double-row bearings can be furnished if desired. These are precision-type ball bearings, double-sealed, pre-lubricated and pre-loaded. Pre-loading is accomplished by means of an inner and outer selected bearing spacer.

A selection of 52 convenient types and sizes of standard slide assemblies are available. The size range runs from 2 to 6 in. width, with lengths from 3 to 16 in. Stocks are maintained of this equipment.

These slides move on dovetail ways. Male and female members are made from wear-resistant iron having high tensile strength and are properly treated to eliminate distortion. Top and bottom surfaces of both members are precision machined and ground parallel. Gibs with adjusting screws are provided for regulating the clearance and compensating for wear as required.

Assembled slides are made with heat-treated, compression-type return springs, mounted on guide pins in an end plate and fitting into drilled holes in the male member. An adjustable stop screw is also provided for regulating the length of travel of the slide. An oil-resistant shield protects sliding surfaces from dirt, chips, abrasive material. The male member has two drilled and countersunk holes to receiver socket head cap screws for mounting.





The 2 in.-wide slides come in lengths of 3, 4 and 6 in., with a maximum travel of $\frac{3}{4}$, 1 and 2 in., respectively. The 3-in. wide slides are available in lengths of 4, 5 and 6, with a maximum travel of 1, 1 and 2 in., respectively. The 4-in. wide slides can be obtained in lengths of 6, 8, 10 and 12 in., with a maximum travel of 1, 2, 2, and 3 in. respectively. The 6-in. wide slides are offered in lengths of 8, 12 and 16 in., with a maximum travel of 2, 4, and 4 in., respectively. Russell T. Gilman, Inc., 2410 N. Farwell Ave., Milwaukee 11, Wis.

For more information—Circle 32, inside back cover

AN ETCHED METAL-AND-ENAMEL NAMEPLATE is said to have the ease of application of a decal. It is affixed by a permanent pressure-sensitive adhesive which eliminates the need for rivets and permits removal of the plate without leaving mutilating holes. These nameplates withstand temperatures from -58 up to 257 F, resist abrasion and color fading. Miller Dial & Nameplate Co., 4400 North Temple City Blvd., El Monte, Calif.

For more information—Circle 33, inside back cover

OVAL AND FLAT-OVAL SHAPED CAPACITORS have been expressly designed for a-c applications where need for space-conservation is a factor, such as motor-starting and motor-running hookups, fluorescent lighting, power factor correction. All four new styles are metal-cased, with paper dielectric. Each is smaller in size and lighter in weight than comparable rectangular shaped cases. Cornell-Dubilier Electric Corp., South Plainfield, N. J.

For more information—Circle 34, inside back cover

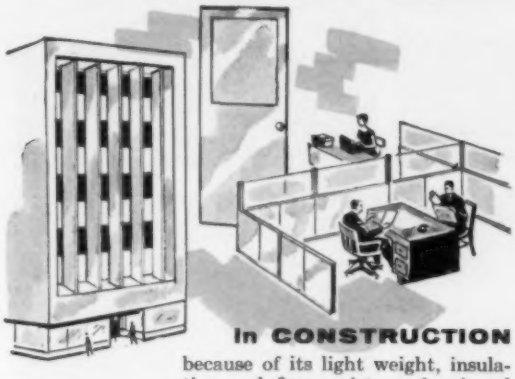
A DRAFTING TAPE is said to hold tracing paper or cloth firmly on drafting or drawing boards yet come off the roll cleanly, apply easily and still leave no defacing or discoloring marks on the drawing paper or cloth. This pressure-sensitive tape is available to the industrial market in 60 yd. rolls, boxed or bulk packed. There are 17 standard widths of this new tape ranging from $\frac{1}{4}$ to 3 in. Behr-Manning Corporation, Troy, New York.

For more information—Circle 35, inside back cover

CONTINUED ON PAGE 244

REYNOCELL®

THE MIRACULOUS NEW MATERIAL WITH BOUNDLESS USES



In CONSTRUCTION

because of its light weight, insulation and fire, moisture, fungi and pest resistance . . . movable partitions • folding partitions • interior curtain walls • residential doors • industrial and garage doors • solar shades • advertising signs • lean-to bomb shelters • shelving, etc.

For PORTABLE EQUIPMENT

because of its light weight and structural strength . . . billboards • pallets • platforms • stage scenery • trailer and truck body parts • work stands, etc.

For INSULATED STRUCTURES

because of its excellent thermal insulation, light weight and strength . . . liners for refrigerator trucks and cars • walk-in refrigerators • refrigerated vending machines • shipping containers • oven jackets • heat baffles • preheating chambers • chicken incubators • bakery proof boxes, etc.

For FURNITURE

because of its modern beauty, light weight and fire and moisture resistance . . . desks and tables • cabinets • drafting boards • bed ends • store fixtures • portable bars, etc.

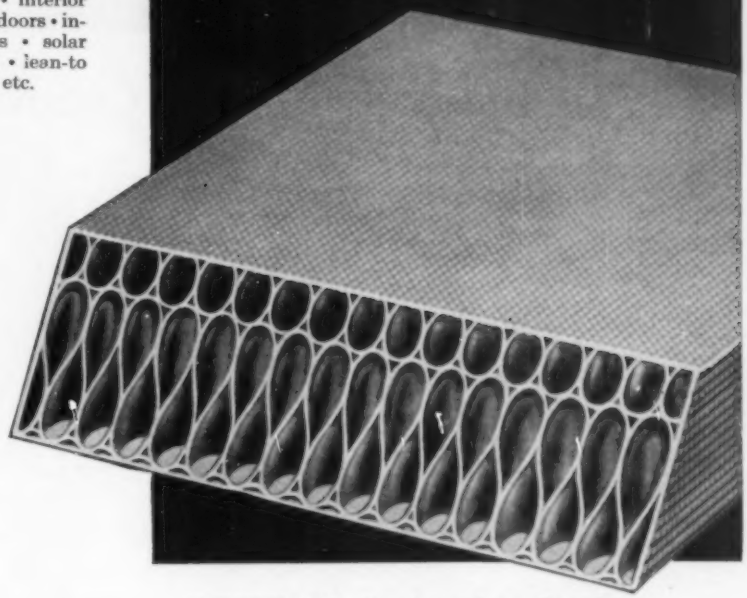
WHAT REYNOCELL IS:

Reynocell panels are extremely light, strong, rigid, prefabricated structural units. They have a honeycomb core of resin-impregnated kraft paper to which aluminum facings are securely bonded.

ITS PROPERTIES:

(Typical, based on 4" thick panels. Comparably favorable properties apply to other thicknesses.)

- Weight—1.46 lb/sq. ft.
- Bending Strength—180 lb/sq. ft. of uniformly distributed load on 8' span
- Deflection—¼" with 47 lb/sq. ft. of uniformly distributed load on 8' span
- Crushing Strength—70 psi
- Thermal Insulation (U factor)—.135



REYNOLDS Engineering Service

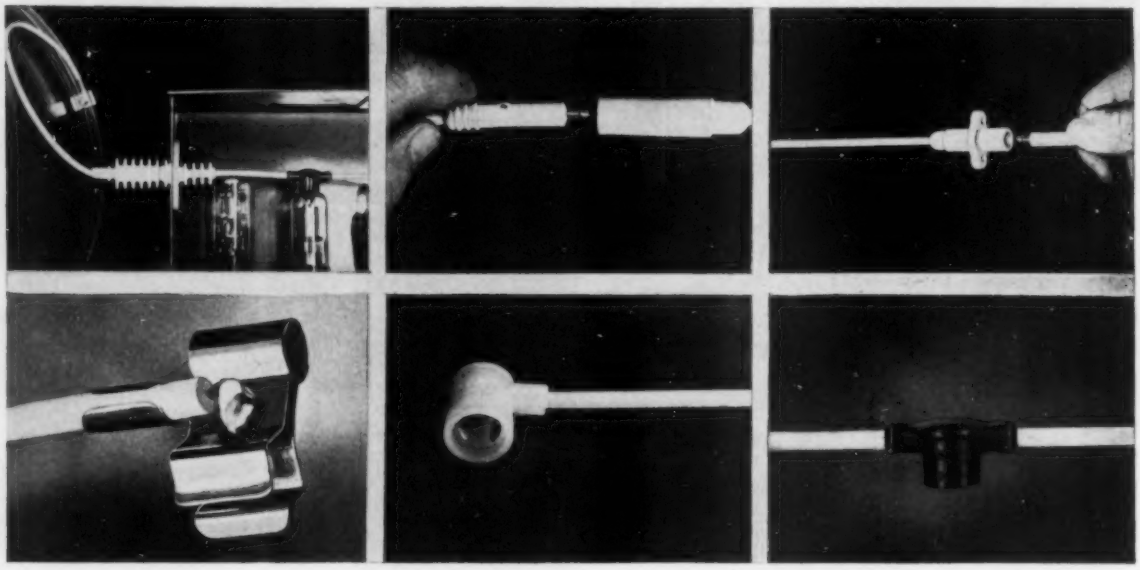
Reynolds engineers are working with a number of manufacturers on a variety of applications. Their assistance is also available to help you apply the many advantages of Reynocell Panels to your products.

Call your nearby Reynolds office listed under "Aluminum" in classified phone directories. Or write for more complete information and answers to your design questions. New applications and test data that may be helpful to you are accumulating every day. Reynolds Metals Company, 2561 So. Third Street, Louisville 1, Kentucky.

*T.M. registered

REYNOLDS ALUMINUM

MODERN DESIGN HAS ALUMINUM IN MIND



Integrally Molded Connector Cables

A cabling technique has been developed that permits molding several cable connector components into one integral unit by molding the connectors right onto the wire insulation. Developed for color television, these integrally molded cables are expected to find application in other areas: high voltage power supplies, high voltage rectifier circuits in such equipment as radar, transmitters, X-ray.

The cost is low, space is saved and the problems of strain relief, wire insulation pull back, wire fatigue under vibration, high voltage arc-over at wire holes are said to be elim'nated or minimized. Compact designs are possible because of a homogeneous body of insulation molded right around the contacts and leads.

A minimum of material is required by eliminating the need for long leakage paths at the wire joints. The high voltage potential sources are sealed into the insulating jacket, greatly reducing the problems of corona suppression and shielding. Only the female contacts are exposed to the air and only at the point of mating where there is a natural damping of corona.

The high voltage connector cables can be tailor-made to fit specific applications with a whole series of high voltage disconnects, tube cap and tube socket connectors. From this series of components the engineer may select those that suit his application. The manufacturer will mold these components into one integrated unit such as the high voltage anode cable shown at the top, left in the accompanying illustration. Alden i'roducts Co., Brockton, Mass.

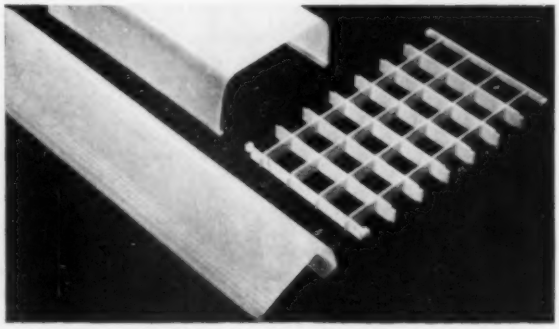
For more information—Circle 36, inside back cover

Light-Stable Polystyrene At No Extra Cost

A new light-stable formulation of polystyrene plastic is reported to offer eight to ten times better light stability than general purpose polystyrene, while retaining the characteristic physical and chemical properties of the general purpose material and costing no more. It may also be used for interior display signs, escutcheons, instrument dial faces and panels, venetian blind components, and window shade pulls. Stabilization of the polystyrene results in non-yellowing crystal and white colors, the most commonly used shades for light fixture.

Styron 647 is expected to prove particularly applicable where light diffusion and light transmission properties are of prime importance. Dow Chemical Co., Midland, Mich.

For more information—Circle 37, inside back cover



—CONTINUED ON PAGE 246

Facts you should know about DE LAVAL *worm gearing*

How master worm control gives you 4 vital advantages

This photograph shows inspector making a final check of contact and backlash on a De Laval gear set which has been process-inspected all along the line. A De Laval master worm "rides" with every job . . . insures start-to-finish quality control.

Since De Laval maintains a wide range stock of master worms as reference standards, you can be sure of:

- **Unvarying uniformity**
- **Correct thread thickness**
- **Preciseness of tooth contour**
- **Interchangeability of parts**

De Laval manufactures heavy duty worm gear sets in *ratios from 3:1 to 100:1, with ratings of .1 hp to 550 hp and center distances from 3" to 36".*

A New Working Tool for You!

Worm Gear Sets Catalog 5000 contains 38 pages of vital data. Write for your copy on your business letterhead.

DE LAVAL *Worm Gear Sets*

DE LAVAL STEAM TURBINE COMPANY

801 Nottingham Way, Trenton 2, New Jersey

DL 224

Gas Flow Control and Measurement

This flow control and measurement meter operates under any condition where the ratio of absolute pressure downstream from the nozzle to absolute pressure upstream (in the housing) is equal to or less than the so-called critical pressure ratio for the fluid measured. Under this condition, the fluid moves through the nozzle throat at sonic velocity, neither more nor less; variations in downstream pressure have no effect on the rate of flow, so long as the critical pressure ratio is not exceeded. Steam and other gases in refineries, petrochemical, solvent, food and other processing plants are said to be readily metered, proportioned or allocated.

Weight flow is directly proportional to upstream or meter housing pressure. A simple gage measuring only the upstream pressure can be used to measure the rate of flow. Also, this pressure can be used as the input to any recording or controlling system.

Within the range where the pressure ratio is no greater than the critical pressure ratio, fluctuations in the downstream or process pressure cause no change in flow. By controlling the single upstream pressure, an effective and highly accurate control of the rate of flow is maintained.

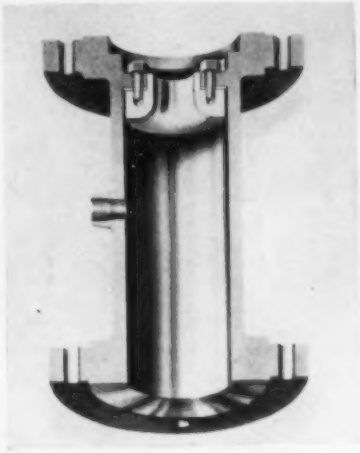
The new flow-control device consists of two simple parts: a housing containing a nozzle made from chrome carbide or hardened stainless steel, to provide maximum resistance to erosion and corrosion, and a flow indicator connected to the housing. Where desired, a controller or a recording pressure gage, or both, can be used either together with or in place of the dial-type flow indicator.

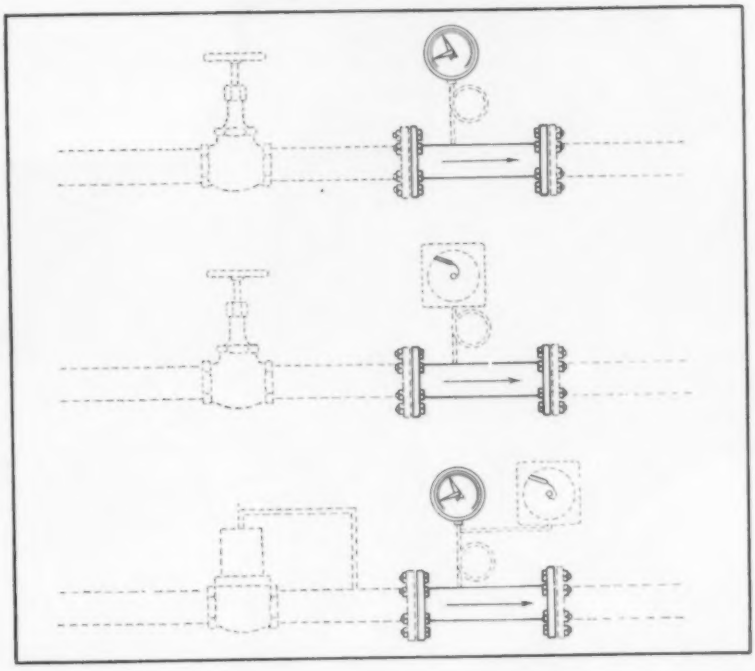
Accuracy of the meter readings depends solely upon the accuracy of the indicator or recorder used. The unit itself is as accurate as the available thermodynamic data for the gas or vapor whose flow is being measured.

This instrument can be used with the flow indicator and a throttling valve upstream, to give a visual measurement of flow and permit manual change of the rate of flow. It can be used with a simple pressure recorder, to permit recording the flow. It can also be used as an indicating or recording flow controller, with a pressure-regulating valve upstream.

In addition, the instrument can be incorporated into any complete control system, since its single pressure output is directly proportional to the rate of flow. King Engineering Corp., Ann Arbor, Mich.

For more information—
Circle 38, inside back cover





EXTRUDED SOLID POLYETHYLENE RODS as large as 6 in. dia and over 7 ft long are now available. An ingenious cooling system used in production is said to assure non-porous, void-free lengths of this new plastic rod. H & R Industries, Nazareth, Pa.

For more information—
Circle 39, inside back cover

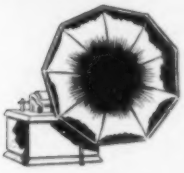
HOSE designed to handle hot acids and all plating solutions is now available for shipment from stock in sizes of 1, 1½, 2 and 2½ in. ID. Larger sizes can be provided if needed on reasonable delivery schedules.

This hose is constructed of butyl rubber with four-ply reinforcing. Tests have proved the ability of this hose to stand up under all hot acids except nitric or chromic. Further tests show that the hose does not contaminate plating solutions. Suitable fittings and stainless steel hose clamps are also in stock for immediate shipment. Carl Buck and Associates, Essex Fells, N. J.

For more information—
Circle 40, inside back cover

CONTINUED ON PAGE 248

Gilmer V-Belts have this BIG advantage!



REMEMBER how the invention of the radio amplifier opened the way for the ultimate perfection of the much older mechanical phonograph? In much the same way, the invention of the Gilmer "Timing"® Belt has contributed to the present perfection of its older teammate, the Gilmer V-Belt!

During the past decade, while developing and improving the first successful molded-tooth belt, Gilmer engineers explored and tested countless combinations of new design ideas, synthetic rubber formulations, textile fabrics and cord compositions . . . uncovered much that was applicable to V-Belts as well as to "Timing" Belts!

Many of these tougher, better-gripping, cooler-running rubber compounds, longer-wearing cover fabrics and stronger cords of man-made continuous filaments have been incorporated into Gilmer V-Belts. But, since these improvements did not occur all at one time, we have never gone so far as to announce a "new line" of Gilmer V-Belts. However, you can be sure that the Gilmer V-Belts you buy today, from your NYB&P-Gilmer Distributor, embody the most advanced materials and proved designs to provide maximum performance and service life.

Let your nearby NYB&P Distributor fill all your V-Belt needs! If he is not listed in your local classified directory, write for his name to address below.

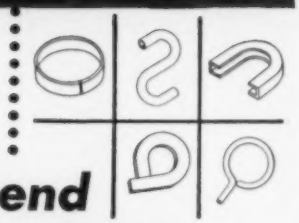
Gilmer V-BELTS and "TIMING"® BELT DRIVES

NYB&P INDUSTRIAL RUBBER GOODS

NYB&P — NEW YORK BELTING & PACKING CO. Founded 1846

NEW YORK BELTING & PACKING CO. 1 Market St., Passaic, N. J.

America's Oldest Manufacturer of Industrial Rubber Products

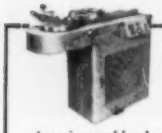


Bend a Variety of Materials

Accurately, Easily, Quickly with a DI-ACRO* BENDER

Simple and complex bends can be formed and duplicated in many ductile materials with a versatile Di-Acro Bender. Bending capacity of the five hand operated models ranges from 1/16" wire to 1" round mild steel bar. Many accessories are available for bending various materials and shapes. The Di-Acro Bender can be delivered completely tooled for most forming requirements in solid materials and tubing.

*Pronounced Die-ack-ro



DI-ACRO HYDRA-POWER BENDER

A universal hydraulically operated bending machine that is equally as flexible as hand operated machine. Di-Acro Hydra-Power Benders are especially designed for those long runs and heavy bending operations which are impractical for manually operated equipment.

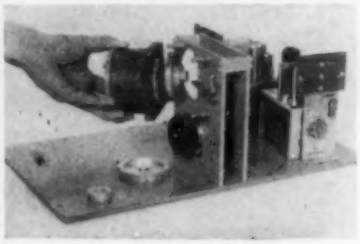
Creators of "DIE-LESS DUPLICATING"

WANT MORE INFORMATION?
Send for New 32-Page Catalog

Gives complete details on hand and power operated Di-Acro Benders, Brakes, Notchers, Punch Presses, Rod Parters, Rollers and Shears. Send for your copy today—there's no obligation.

O'NEIL-IRWIN MFG. CO.
333 8th Avenue
Lake City, Minn.

di-acro PRECISION METALWORKING MACHINES

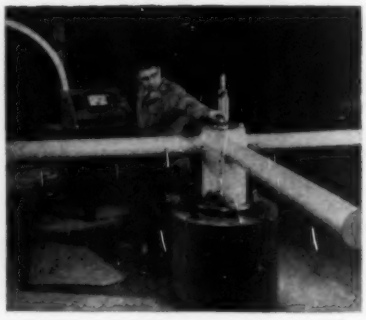


Electronic and Mechanical Servo Components

A complete line of electronic and mechanical servo components for use in standard servo and computer assemblies have been announced which can be used interchangeably in laboratory prototypes and actual production units.

The mechanical components include friction clutches, gear boxes, gears, cams, mounting brackets and base and upright plates. The light-weight electronic components are the building-block, plug-in type. They include servo and summing amplifiers—which are high-gain, low-phase shift units—and phase and linear phase detectors—which are accurate and sensitive units requiring no adjustment, tube selection or balancing. Link Aviation, Inc., Binghamton, N. Y.

For more information—
Circle 41, inside back cover



Vertical Rod Checks Balance of Rotating Members

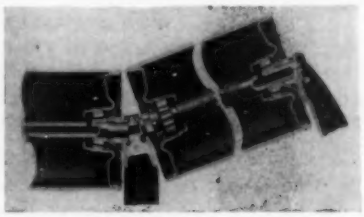
Extremely high standards of accuracy and sensitivity in the static balancing of rotating parts such as cooling fans, helicopter rotors, and other rotors are asserted to have been established with a newly developed vertical balancing rod on which SR-4 resistance wire strain gages are bonded. Imbalance and its location are detected by bending strains in the rod.

The high sensitivity of the balancer has been demonstrated in many tests, including a 40-ft rotor for a helicopter. The blades were balanced to 4 in.-oz, although specifications required balance only to 8 in.-lb.

The time for making tests of such accuracy was reduced substantially also. In one instance a 2,000-lb propeller was balanced in 15 to 20 min, in contrast to 3 to 4 hr with the conventional method.

Another outstanding feature of the SR-4 strain gage balancer is its ability to correct the balance of weight across the width of helicopter blades. No other balancing method can correct this, it is reported. Other means of correction have required as much as two days. Baldwin-Lima-Hamilton Corp., Philadelphia 42, Pa.

For more information—
Circle 42, inside back cover



Conveyor Belt Idler

The main feature of this conveyor belt idler is the dual flexible contact seals which, laboratory and field reports indicate, perform the double function of keeping out dirt and retaining the grease, for practically an endless period of time. Since the idler is factory packed, adjusted and sealed, this creates a permanently lubricated idler. When and if it should be desirable to regrease, the design of the idler permits this to be done from either end, through the shaft, the grease reservoir and the shaft connectors.

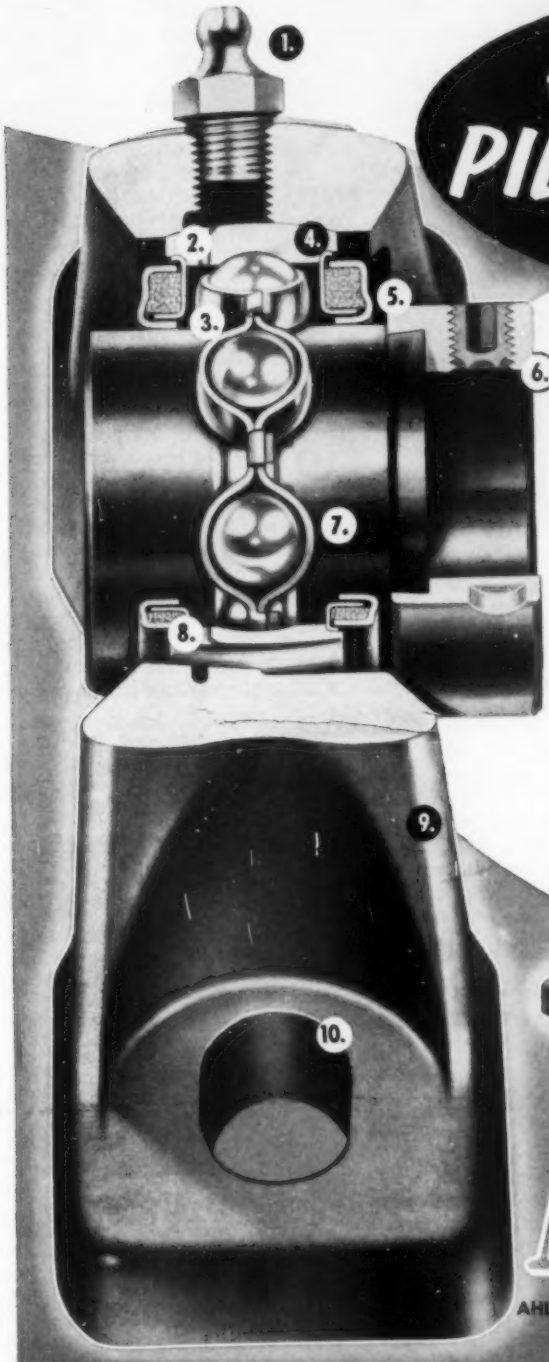
With this series of idlers, roll removal is accomplished without loosening or removing the stands. Rolls are held in place during shipment and operation by means of straps on center and end stands. Fine threading provides minute bearing adjustment. The lock-in type construction, through the grooved adjusting nuts, provides a rugged, truss-type construction.

Extra heavy, electric-welded steel pipe of full and uniform thickness from end to end, form the belt-carrying rolls, which are machine beveled on the ends to protect belt and workmen. Formed steel roll ends are pressed and welded into the pipe shells effecting maximum strength and true run-

NEW!

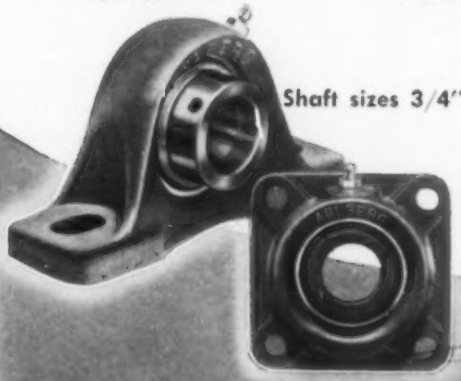
10 key features in a brilliant new design

the Ahlberg "SP" PILLOW BLOCK



Good news for bearing users! The new SP combines all modern pillow block features to give you finer performance . . . longer life . . . greater economy!

1. Grease fitting for re-lubricating
2. Pre-lubricated bearings
3. Generous lubricant reservoir
4. Fully self-aligning
5. Dirt-proof, leak-proof flinger type seal
6. Eccentric type shaft lock
7. Maximum size balls for greater capacity
8. Equal load distribution for longer life
9. Strong, rigid housing
10. Elongated bolt holes for interchangeability



Shaft sizes 3/4" to 2-15/16"

Write for catalog

AHLBERG

AHLBERG BEARING COMPANY, 3025 W. 47th St., Chicago 32, Ill.

Precision bearings since 1908

CAMS...

THAT MAKE NEW MACHINERY *THINK*

In supersonic aircraft controls . . . in automation . . . in every field of enterprise — machinery is literally being made to *think!*

The guiding genius of true automatic control — of superhuman functional speed, uniformity and accuracy — is a man-made cam. And back of this mechanical brain are the inventive minds and skilled hands of engineers and craftsmen such as those at Parker. A pioneer in the field of *3-dimensional cams,* Parker has complete facilities for their design, development and production manufacture — plus an enviable reputation for precision and leadership in the creation of cams that can make machines repeat the most exacting operations — without the possibility of human error.

Send today for the amazing story of the Parker Engineered and Produced Cam that achieved nationwide recognition and applause.

by Parker

THE PARKER STAMP WORKS, INC.
MARKING DIE & MACHINERY DIV.
FRANKLIN AVENUE
HARTFORD, CONNECTICUT

ning rolls. This series of idlers features the 2 deg tilted end stands for engineered belt training. This tilt in the direction of belt travel tends to give the center roll of the troughing idler more control over the belt.

Auxiliary units for the new equipment include impact absorption idlers, troughing training idlers, plain return idlers, return training idlers, spool return idlers and spool return training idlers. Jeffrey Mfg Co., Columbus 16, Ohio

For more information—
Circle 43, inside back cover

Registers Blueprint Footage Up to 2400 Ft

Three footage registers, indicated on the dial face, allow this instrument to record distances of up to 2400 ft on blueprints scaled $\frac{1}{8}$ in. to 1 ft, 1200 ft on prints scaled $\frac{1}{4}$ in. to 1 ft, and 600 ft on drawings scaled $\frac{1}{2}$ in. to 1 ft. Possibility of error is minimized by a small hand, centered in a dial-within-the-dial, that moves forward one division with each complete revolution of the long hand. Both hands are returned to zero by light pressure on a lateral push-button. M. Ducommun Co., 580 Fifth Ave., New York, 36, N. Y.

For more information—
Circle 44, inside back cover

Automatic Transmission And Differential

An automatic clutch, transmission and differential has been designed for use on garden tractors, lawn tractors, midget cars and other two-wheel propelled units. Unlike other differentials, this device drives each belt independently as well as differentially. Two separate countershafts are driven to turn the traction wheels. On a curve or in a turn, the inside wheel is said to rotate more slowly and to downshift to "low." The outside wheel naturally speeds up and shifts into "high."

No controls other than the engine throttle are required with the new drive, since governors operated by centrifugal force expand to operate the floating cones. Engagement speed is pre-set at the factory and occurs at 1800 rpm or higher, depending upon the belt load. When crankshaft speed is reduced or the engine is idling, the belts are released.

The drive is quickly installed on a $1\frac{1}{2}$ in. or longer horizontal shaft. These units are now available for "A" or "B" belts and $\frac{5}{8}$ or $\frac{3}{4}$ in. shafts for up to 4 hp gasoline engines. V-Plex Clutch Div., Hagerstown, Ind.

For more information—
Circle 45, inside back cover

Foot Switch for Electronic Equipment

A foot switch for heavy-duty operation of electronically operated units has a cast iron housing with a sponge rubber skid pad to prevent sliding. It is easily operated from either a sitting or standing position. The switch is said to be nearly 100 percent dustproof, yet it is accessible for wiring—the removal of two screws exposes the inner mechanism. The entire unit weighs 2 lb. Linemaster Switch Corp., 424 Woodstock Terrace, Woodstock, Conn.

For more information—
Circle 46, inside back cover

Relay for Tight Quarters

This new sensitive relay was designed primarily for use in electronic chassis which have sufficient height but little adjacent space. It is expected to have a wide range of application, including atomic instrumentation, tran-

NOW

A Midget 4-WAY Solenoid Valve . . . For Controlling Small Double Acting Cylinders

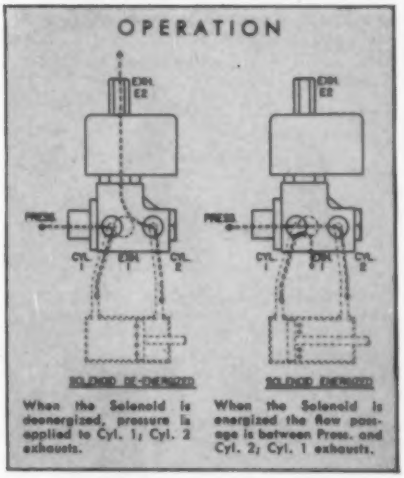
Pipe Size: ¼"
Pressures:
Maximum 125 psi
Minimum 10 psi

Fluids Handled:
Air, Water, Light Oil, Non-Corrosive Gases and Liquids

Extremely Compact to Meet Critical Space Requirements

FEATURING:

- **Compactness** — $4\frac{15}{32}$" Overall Height; $1\frac{31}{32}$" Width; 2" Depth; (With Standard NEMA I Solenoid Enclosures).
- **Rapid Operation** — Up to 400 cycles per minute.
- **Ruggedness** — Tested for millions of maintenance free operations.
- **Low Power Consumption** — Only 10 watts!
- **Tight Seating**—Assured by integral crown seats and resilient and nylon discs.
- **Standard, Watertight or Explosion-Proof Solenoid Enclosures available.**
- **Simplicity** — Single Operating Coil — only one electrical connection to be made.
- **Forged Brass Body** — Insures complete freedom from porosity.


OPERATION
EXH. E2
PRESS.
CYL. 1
EXH. E1
CYL. 2
SOLENOID DE-ENERGIZED
When the Solenoid is deenergized, pressure is applied to Cyl. 1; Cyl. 2 exhausts.
SOLENOID ENERGIZED
When the Solenoid is energized the flow passage is between Press. and Cyl. 2; Cyl. 1 exhausts.

NOW ASCO has available **a complete line of Midget 2, 3, & 4-Way Solenoid Valves** — an important addition to the thousands of types and sizes in the standard ASCO line.

WRITE FOR COMPLETE INFORMATION ON "ASCO MIDGET VALVES"

We also design and manufacture Control Panels to provide "Single Source Responsibility" for the Complete Automatic Control. ASCO Electromagnetic Control Equipment includes Close Differential, Time Delay, and Magnetically or Mechanically Held Relays, Contactors, Automatic Transfer Switches and Remote Control Switches.

ASCO Solenoid VALVES

Automatic Switch Co.

385 LAKESIDE AVENUE · ORANGE, NEW JERSEY

Welded steel points the way for the product engineers who

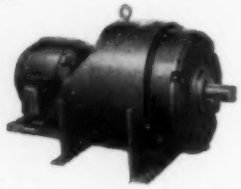
WANT TO CUT PRODUCT COSTS 50%

Proper Design in Welded Steel is *Always* Lower in Cost

Material Cost is Less—It's a fact . . . steel is three times stronger than iron, two and a half times as rigid. Where strength alone is needed, one-third the metal is necessary. When rigidity is important, less than half the material is required. But steel costs only one-third as much per pound. Steel is more easily placed where it can carry more load per pound of metal. As a result, ultimate savings with steel are limited only by the resourcefulness of the designer.

Manufacture is Simpler—Fewer manhours . . . simpler, less costly production tools are needed to manufacture products from steel. By proper design, many operations needed for machining castings can be eliminated entirely. Assembly operations can be simplified . . . finishing and cleaning manhours reduced substantially.

Products designed in steel have a modern appearance to improve selling appeal while reducing costs on an average of 50% according to field reports.



Welded Design Saves 50% *on motor gear housing. Original cast construction weighed 175% more . . . required 90% more machining.*

Cost Down 57% *on machine stand by change to welded steel. Also eliminates former milling and drilling on former castings.*

HOW TO START A COST REDUCTION PROGRAM

Your Lincoln Representative is a specialist in welded design. We will gladly assist your engineers in restudying designs to determine where and how welded steel can save an average of 50% in the manufacture of your products. Call or write.

Design Bulletins also available to product engineers by writing on your letterhead to

THE LINCOLN ELECTRIC COMPANY
DEPT. 1304, CLEVELAND 17, OHIO

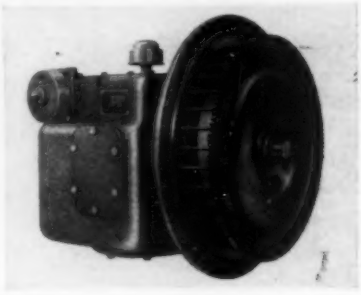
sistors, germanium diodes and telephone operations.

The new relay provides a hermetically sealed double-pole, double-throw combination and has a capacity up to 3 amp inductive load. It is equipped with a standard octal socket. Wattage consumption is 0.1 and less, depending on the contact arrangement, or less than 1 milliampere, depending on the voltage used. The relay shows no fatigue or deterioration after 25,000,000 operations.

The new relay is made of nickel alloys with pure silver contacts. No hinge pins are used in its construction. The armature is free of friction.

Coil resistances of the new relay can be furnished up to 30,000 ohms. D-c relays with a drop-out approximately 80 percent of the pick-up are now in production; a-c relays are expected to be in production shortly. Hedin Tele-Technical Corp., 640 W. Mt. Pleasant Ave., Livingston, N. J.

For more information—
Circle 49, inside back cover



Compound Planetary Type Transmission

A compound double planetary type transmission of 150 ft-lb input torque for use with a torque converter having a 2.12 multiplying factor has been designed for fork-lift trucks, hoists, cranes, car pullers, slushers, truck mixers, earth movers, machine tools. The PGT-150 transmission can be shifted from any place convenient to the operator, but with complete disregard to location of the transmission, from full speed forward to full speed reverse, in only 1½ sec without vibration or jerk.

The shift is made by contracting or releasing the heavy bands of the two planetary systems. A cushioning effect is achieved when oil is squeezed from the area between band and anulus or drum. Hydraulic pressure for actuating controls, internal lubrication, and flow to torque converter is supplied by a built-in oil pump. This pressure is used to contract the bands while spring pressure returns them to open positions. High speed forward is obtained by driving through a built-in, hydraulically actuated multiple disk clutch.

Complete control is accomplished by moving a single hydraulic valve lever. Because all gears of the two planetaries are always in mesh, no damage to the transmission results from wilful abuse or careless manipulation of the control lever. Operator can switch the hydraulic pressure at any speed, at any time, to any position. Ratios are: 1:1 in high, 3:1 in low, and 3.2:1 in reverse. Optional low is 2.23:1. American Gear & Mfg. Co., Lemont, Ill.

For more information—
Circle 47, inside back cover

Expansion Joint With Wedge Seal

An expansion joint that is being manufactured in all pipe thread sizes from ½ to 6 in. has two ball seats that have a Teflon spring-seated wedge seal. The wedge seal is said to seat without leakage because of this spring and the pressure involved. Yet it will not adhere to the metal. The two ball seats and the inside of the expansion joint tube are hard chrome-plated for easy sliding action.

These joints are capable of handling up to 150 lb steam pressure at a temperature from —65 to 500 F. The ball seats permit a flexible action, which gives this new joint complete freedom of movement, taking care of deflection in the piping, any twisting action of the pipe and any expansion. The total eccentricity designed into this joint will be 10 deg on each end. These joints can be made in steel, stainless steel or bronze. Rotherm Engineering Co., Inc., 7280 W. Devon Ave., Chicago 31, Ill.

For more information—
Circle 48, inside back cover

Bypass And Restrictor Type Flow Regulator

This 1-in., non-adjustable combination bypass and restrictor type, pressure compensated flow regulator is used to maintain a constant flow when pump output varies or is greater than required for part or all of the system in products such as machine tools, cars, trucks, mining machinery and materials-handling equipment. Over-speeding of the controlled circuit when pressure at the bypass port is high is said to be prevented by the restrictive de-

Why you can *lower inspection costs*

with a Kodak Conju-Gage Gear Checker

Why the composite check

The composite check recommended in American Standard B6.11-1951 tests gears functionally by running the gear against a master of known accuracy. The resulting displacement shows at once the cumulative effect of as many as six types of error—eliminates time-consuming checks for each individual error. The check is rapid and conclusive.

Why the Kodak Conju-Gage Gear Checker

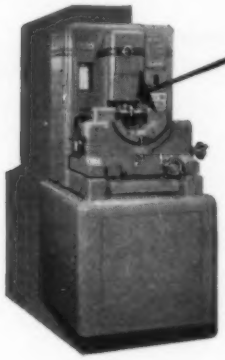
To meet today's tolerance requirements, the Kodak Conju-Gage Gear Checker uses a master made with a new order of precision. This is the Kodak Conju-Gage Worm Section, produced by thread grinding under control of a precision lead screw.

The accuracy inherent in this method means every right gear is passed by the worm section, reducing rejection losses. The transverse curvature produced by this method provides a master that can be used to check any gear of like pitch and pressure angle, regardless of helix.

Not only can a single worm section be used in place of a number of circular masters, but such a worm section can be reground to specification as often as necessary—at a fraction of replacement cost. It is easily checked for accuracy by familiar toolroom procedures.

You can find out more about the economies possible through Kodak Conju-Gage Instrumentation by sending for a copy of the booklet, "Kodak Conju-Gage Gear Testing Principle." Write to:

Special Products Sales Division
EASTMAN KODAK COMPANY
Rochester 4, N. Y.



The Kodak Conju-Gage Gear Checker automatically records the composite effects of runout, base pitch error, tooth thickness variations, profile error, lead error, and lateral runout. Illustrated is the Kodak Conju-Gage Gear Checker, Model 4U, for gears up to 4⅛" pitch diameter. Larger and smaller models are also available.

CONJU-GAGE INSTRUMENTATION

... a new way to check gear precision in action

To inspect all kinds of complex parts on a bright screen, Kodak also makes two highly versatile contour projectors.

Kodak
TRADE-MARK

No. 6 - Precision Operations in the Manufacture of ACME Chains

Rigid inspection of all Acme Chains is a guarantee that every foot of chain you receive leaves our plant in perfect mechanical condition.

Complete

Production Facilities

FOR QUICK SERVICE

The ACME Organization was built to give prompt and immediate service. The flexibility of our equipment, the crew of skilled mechanics, our large inventory of standard sizes of ACME Chains, and good shipping facilities, all go to give you ACME Chains when you want them -- where you want them.

When you want Roller Chains in a hurry, phone Holyoke 2-9458 and we'll do all we can to help you.

Write *Dept. IM for new illustrated 76 page catalog on use and application of roller chains and sprockets.*

Acme Chain Corporation
HOLYOKE
MASSACHUSETTS

sign feature. Flow from the bypass port can be used for operating other parts of the hydraulic system.

Oil passing through the orifice in the sliding valve creates a pressure differential that pushes the valve back against the spring. Since the spring essentially exerts a constant force, the pressure differential is constant, as is the flow which creates the differential. If this flow increases, the pressure differential also increases, and the valve uncovers the bypass port. If, after uncovering the bypass port, flow through the orifice still tends to increase, the sliding valve moves back farther and throttles the outlet ports.

Regulated flow will not vary more than 5 percent as long as fluid specifications are not materially changed. Flow is only slightly affected by pressure, temperature or viscosity. Fluid Controls, Inc., 1284 N. Center St., Mentor, Ohio.

For more information—
Circle 50, inside back cover

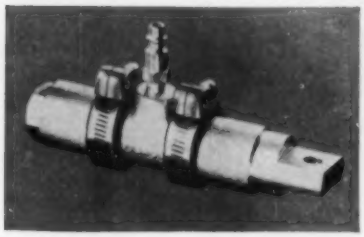
Variable Speed Hydraulic Transmission

This heavy-duty hydraulic transmission consists of a 112 gpm variable and reversible delivery axial piston pump and a constant displacement axial piston motor. The transmission is designed for operating pressures to 3,000 psi. On continuous duty, it has a rating of 50 hp; for peak load applications, 200 hp. Any speed can be maintained between 0 and 1150 rpm.

This unit is now being built in quantity as a winch and hoist transmission. Other potential and actual applications include drives for wire-drawing, chemical processing, heavy machinery, oil-well equipment, draw benches. It is assembled as a packaged unit with all valves and controls built in, including an auxiliary pump, relief and replenishing valves. The pump is servo controlled and has features specially de-

signed for this application, including a constant horsepower device, neutral interlock switch, neutral by-pass and a brake control valve. Pump can be separated from hydraulic motor for a considerable distance and can be remotely controlled. Weight is about 1,000 lb. Waterbury Tool, Waterbury 20, Conn.

For more information—
Circle 51, inside back cover



Small Noiseless Pneumatic Vibrators

These vibrators are designed to reduce processing time by vibrating small bins, chutes, hoppers and screens to prevent arching, clogging or sticking of inert bulk materials without the usual noise of impacting type vibrators. The unit is muffler-equipped, for use in close proximity to working personnel and in areas where low noise level is a major requirement.

The vibrating action is achieved by a piston which reciprocates in a cylindrical passage by introducing compressed air alternately to the opposite ends of the cylinder. It is designed to deliver up to 5,000 strokes per min and to operate on 30 to 140 psi line pressure. An added feature is the exclusive self-contained supercharging design which increases effective operating air pressure from 30 to 60 percent above supply pressure and vibration power output 110 percent. The vibrator is $6\frac{3}{4}$ in. long, weighs $2\frac{1}{2}$ lb, and is also available in models not equipped with mufflers for use in areas where noise is not a major consideration. Burgess-Sterbentz Corp., 3790 West 150th St., Cleveland 11, Ohio

For more information—
Circle 52, inside back cover

Miniature Repeat Cycle Timer

Hermetically-sealed miniaturized repeat cycle timers are supplied in a $2\frac{1}{2}$ in. dia aluminum housing. They are motor driven, and can be supplied with 50, 60 or 400 cycles per second, a-c

Always with
CLEVELAND's SPEEDAIRE
you can be sure of...

Testing Speedaire units prior to shipment.

100% pre-testing

ALL Cleveland Speedaire units are pre-tested under *actual job load.* After a test run, each unit is disassembled for thorough inspection of all vital parts. Adjustments, if necessary, are made. Then the unit is tested again. Only when a Speedaire passes this "shake-down" test, is it shipped on to the customer. This 100% check for part perfection and performance under load assures you that every Speedaire you buy is *right and ready* for the job.

The fan-cooled Speedaire unit marks a notable achievement in Cleveland's continuous program of worm gear drive improvement.

SPEEDAIRE IS ECONOMICAL

Speedaire is Cleveland's fan-cooled worm gear speed reducer. Because of the reduction in unit size that their use permits, Speedaire units *cost materially less* per horsepower transmitted.

You'll find full engineering data on Speedaire as well as the complete Cleveland line in Catalog 400. Write today and ask for your free copy. The Cleveland Worm and Gear Co., 3279 E. 80th St., Cleveland 4, Ohio.

Affiliate: The Farval Corporation, Centralized Systems of Lubrication. In Canada: Peacock Brothers Limited.

CLEVELAND
Worm Gear
Speed Reducers

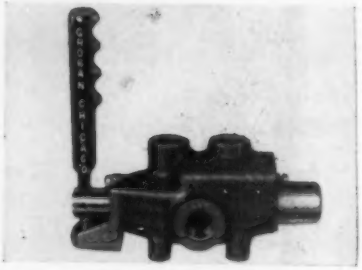
DURAMETALLIC Packings
VALVES
CENTRIFUGAL PUMPS
Throughout your plant
. . . wherever you have stuffing boxes to be repacked, specify Durametallic "Engineered For The Job" products for longer packing life and satisfactory sealing service.
Write today for our packing File No. DMPG
DURAMETALLIC CORP.
KALAMAZOO, MICHIGAN
COMPRESSORS
RECIPROCATING PUMPS

Mass. Gears
...for helpful "know-how" in producing
PRECISION GEARS
The finest kind of service is yours from "Mass Gear" to help you get the gears you need . . . promptly, economically and exactly to your specifications.
Long experienced "know-how" and modern gear-making facilities await your call . . . at "Mass Gear."
Specify your gear requirements . . . ask "Mass Gear" to quote. No obligation of course.
G&T
Massachusetts Gear & Tool Co.
WOBURN, MASS.

standard or governed d-c motors. Radio interference filtering to meet MIL-I-6181 specification is available for d-c units. The extremely low power requirement of the motors used in these timers makes them ideally suited for both local and remote control applications or continuous duty.

A wide range of basic speeds are available and intercam reductions up to 960:1 can be incorporated. These units can be supplied with flange mounting or a three-stud mounting. A. W. Haydon Co., 230 N. Elm St., Waterbury, Conn.

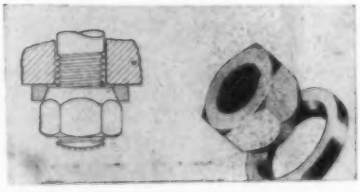
For more information—
Circle 53, inside back cover



Hydraulic Valve With Sliding Spool

This valve has a flow capacity of 16 gpm and it will operate satisfactorily under pressures as high as 1500 psi. Of pressure-balanced, sliding spool design, it can be used for hydraulic loaders, dumps, push-offs, farm machinery and industrial hydraulic circuits. Body is of cast iron and spool is hardened steel, chrome plated. Groban Supply Co., 1139 S Wabash Ave., Chicago 5, Ill.

For more information—
Circle 54, inside back cover



Washer's Spring Pressure Locks Nut

An ordinary nut with a conical lower end that mates with a hardened steel washer makes up a new locknut assembly. Hoop expansion of the washer by the nut's downward thrust results in a spring action which permits the nut to be deflected at a high spring load

with relatively small deflection. The spring load is stated to be equivalent to the safe load of the bolt.

Using this locknut an unskilled workman with an ordinary wrench attains the desired load by wrenching the nut until it expands the washer and automatically "bottoms" on the work. Located below the nut, the spring washer is independent of the usual variables of the torque wrench such as lubrication, plating or surface finish.

Reusability is said to be unlimited. The locknut will not injure screw threads on the bolt and can be tested for load before installing. In structure, the fastener varies very little from the conventional nut and washer. Monze Products Development Co., Los Angeles, Calif.

For more information—
Circle 55, inside back cover

Self-Locking Wing Nut Has Serrated Base

A new serrated base wingnut which frequently eliminates the need for a lock washer has been in use for some years by television antenna manufacturers. Now they have been made available in a full range of popular sizes. These wing nuts are made of rust-proof zinc alloy and feature a patented recessed thumb grip. In addition to a plain bright finish that withstands normal usages they are also furnished in all commercial finishes. Gries Reproducer Corp., 400 Beechwood Ave., New Rochelle, N. Y.

For more information—
Circle 56, inside back cover

Molding Compound For Outdoor Applications

A formulation of nylon resin which is resistant to ultraviolet degradation is jet black in appearance. Preliminary work indicates that the new compound is readily moldable with good gloss, free from smears and dull spots. The properties of the new resin are comparable to those of general purpose

It *was* a problem making threads hold in softer, lighter materials...producing threads that would *never* wear, seize, corrode or gall.

But not since ***Heli-Coil**** Screw Thread Inserts! They make weak threads strong and *perfect*. And they save you weight, space and money because you can use fewer, smaller, shorter fastenings, smaller bosses and flanges.

When it comes to threaded fastenings, thousands of manufacturers throughout the world use ***Heli-Coil*** Screw Thread Inserts to answer their design, manufacture and field service problems. Send today for full information, specifications and samples. And a ***Heli-Coil*** Thread Engineer will be happy to assist at your request.

***Heli-Coil* Inserts conform to official Military Standards MS-122076 (ASG) through MS-124850 (ASG) and others.**

*Reg. U. S. Pat. Off.

HELI-COIL CORPORATION
149 SHELTER ROCK LANE, DANBURY, CONN.

☐ Please send samples and Bulletin 689—Military Standards Sheets.
☐ Please have a *Heli-Coil* Thread Engineer call.
☐ Send samples and Catalog.

NAME_____ TITLE_____

COMPANY_____

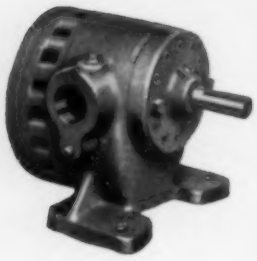
ADDRESS_____

CITY_____ ZONE_____ STATE_____

LIFT

the efficiency of your hydraulic unit with Roper dependable Pumps. Get optimum performance from the pumps that feature just two moving parts — equal size gears operating in a sturdy case with proper clearance for superior service and long life. The models shown are representative of standard Roper pumps suitable for most applications.

Specify
ROPER
Rotary Pumps
FOR YOUR
HYDRAULIC
APPLICATIONS

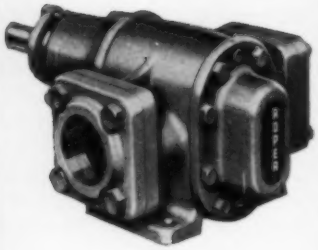


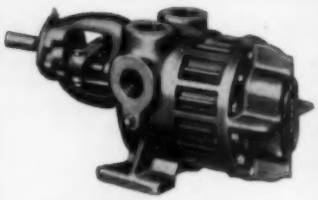
LOWER

maintenance costs with a Roper. For instance, a pump like the Series H with pressures to 1000 P.S.I., sizes 10 to 75 G.P.M. is ideally suited for hydraulic mechanisms and for other applications requiring high pressures. Spur gears run in axial hydraulic balance . . . bearings and bronze wear plates reduce friction under heavy loads. Available with packed box or mechanical seal.

PUSH

the unit in your hydraulic circuit with the correct size Roper for the particular job. In many cases the Series K will do, for it is rated from pressures to 150 P.S.I., capacities ¾ to 50 G.P.M. This model is compact, sturdy . . . is self-lubricated by liquid pumped . . . handles total suction lifts up to 25 feet. Comes with packed box or mechanical seal . . . with or without relief valve.





ROPER
Rotary Pumps

GEO. D. ROPER CORPORATION
379 Blackhawk Park Ave., Rockford, Illinois

PULL

favorable comment on a wise choice when you install a Roper as original equipment. Among the dependable Ropers is the Series F Pump —pressures to 300 P.S.I., sizes 1 to 300 G.P.M. It features four-port design with 8 optional piping arrangements . . . supplied in standard or stainless steel fitted models. With packed box or mechanical seal; with or without relief valve.

"Zytel 101" which is already in wide industrial use as a material for gears, bearings, and complex shapes. Applications involving outdoor exposure such as agricultural machinery, automotive equipment, sporting goods, toys, and electrical equipment are expected to develop for this new material. E. I. du Pont de Nemours & Co., Wilmington, Del.

For more information— Circle 57, inside back cover

Two-Switch Governor For Over 350 Rpm

A two-switch governor contains snap action switches rated at 10 amp, 110 v, ac, and can be used for either opening or closing circuits at any rpm over 350. Each switch is individually adjustable up to 2000 rpm above specified set speed. Synchro-Start Products, Inc., Skokie, Ill.

For more information— Circle 58, inside back cover

Impulse Generator Needs Only Slight Force

Aeronautical, mining, railway and general industrial equipment are all expected to be able to employ impulse generator that converts mechanical energy into pulses of electrical energy.

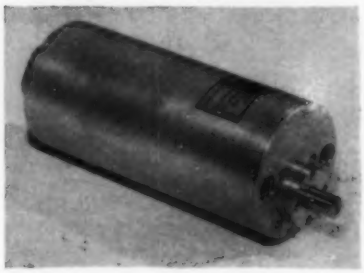
Said to be the first of its kind, the unit was originally developed as an

emergency standby device, to set off explosive charges for the forceable ejection of external aircraft stores and bombs.

The generator is self-restoring after operation without application of additional mechanical force. It operates successfully under water without impairment of electrical characteristics. There is no stored potential energy such as spring-loaded assemblies to cause premature or unintentional operation.

The illustrated unit delivers 5½ w power for pulse duration of 25 milliseconds or longer with fast rise time and minimum pulse lag and decay. Size (which is variable): 5½ in. long, 2 in. wide and 3¾ in. high; weight (with these dimensions): 2 lb, 12 oz. The generators can be hermetically sealed. Microloc, 5811 Marilyn Ave., Culver City, Calif.

For more information—
Circle 59, inside back cover



High-Torque Rotary Actuator

A miniature rotary actuator is said to be the smallest and lightest for its capacity (up to 2,000 in.-oz). It measures 2x5 1/16-in. and voltage range is from 6 to 100v.

The unit consists basically of a permanent magnet assembly and a planetary gear reduction unit. For special applications, unit can be modified for specific speed, backlash, switching, braking, torque and other requirements. Globe Industries, Inc., 1784 Stanley Ave., Dayton 4, Ohio

For more information—
Circle 60, inside back cover

Magnetic Servo Amplifier

The R6G10W1 magnetic amplifier is suited, without need of a pre-amplifier, for many medium performance indicating or position-type servomechanisms. Through the addition of a simple preamplifier, it may be em-

Eliminate Costly Machining with MICROCAST

This industrial component was formerly produced from solid stock by conventional machining methods. When produced by the MICROCAST process of precision investment casting, substantial savings resulted . . . close to 50% of each production dollar.

The MICROCAST technique enables you to economize on small parts and components by eliminating or substantially reducing costly machining operations. Another important advantage is its ability to cast high-temperature alloy parts and components at a lower cost than any other production method.

Write for free booklet. Full color sound film on the Microcast process available without charge.

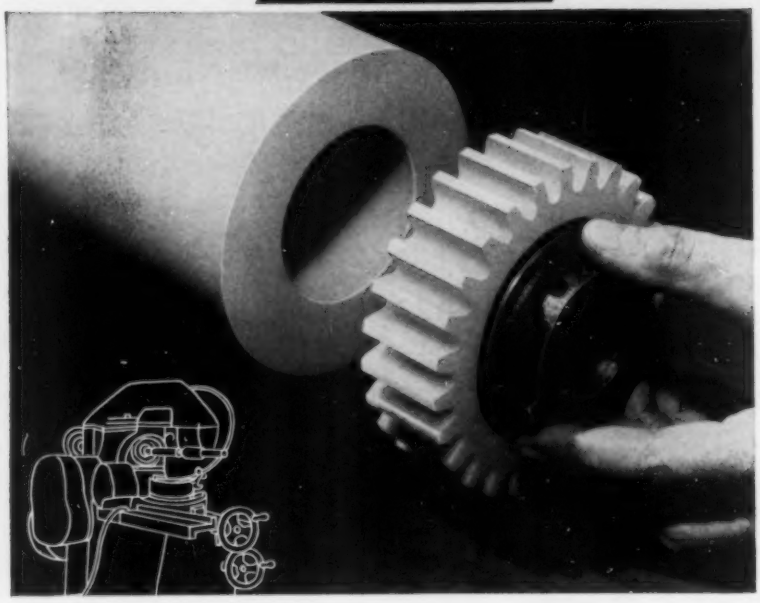
MICROCAST PRECISION CASTINGS PROCESS

microcast

MICROCAST DIVISION, Austenal Laboratories, Inc.
224 East 39th Street, New York 16, N. Y.
7001 South Chicago Avenue, Chicago 37, Ill.

THE ORIGINAL PROCESS FOR MASS PRODUCING PRECISION INVESTMENT CASTINGS

POLYPENCO® NYLON SHAPES



NOW! Get Nylon's Performance in Gears, Bearings . . . at Lower Cost

• POLYPENCO tubular bars now enable you to get nylon's advantages in gears, sleeve bearings, bushings, packings, and other large parts with big cost savings. Machining practically eliminates tooling cost, and this thick-walled stock assures minimum waste of nylon. Further savings can be obtained in nylon gears and rollers by making the outer sections from this stock and then combining them on metal inserts. POLYPENCO tubular bars are now available in 2" to 10" O.D.'s with ⅜" to 1½" walls. With this and other POLYPENCO shapes, you always get these advantages:

- Economical fabrication of one part or thousands on standard metalworking tools in your own shop
- Design flexibility . . . closer tolerances in many kinds of parts
- Uniform high quality in every piece
- Immediate delivery of most standard sizes
- Technical help

Write for new bulletin on nylon shapes.

The POLYMER CORPORATION of Penna. • Reading, Penna.
In Canada: Polypenco, Inc., 2052 St. Catherine W., Montreal, P.Q.

POLYPENCO® NYLON
... teflon* and other non-metallics

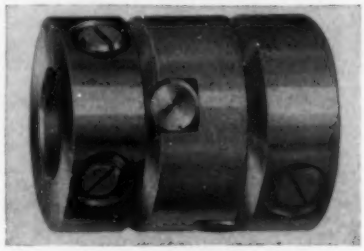
Warehouse stocks: Reading • Chicago • Los Angeles • Newton (Mass.) • Branford (Conn.)

*trademark for DuPont tetrafluoroethylene resin

ployed in what are described as the most accurate and demanding type of control systems.

Design for 1-cycle response assures the widest possible band width consistent with the use of 60 cycle per second as the power supply frequency, and thus reduces many of the stabilization problems formerly encountered when incorporating magnetic amplifiers in servomechanisms. This amplifier delivers 10 w reversible phase output for reversible phase a-c or reversible polarity d-c input. Polytechnic Research & Development Co., Inc., 202 Tillary St., Brooklyn 1, N. Y.

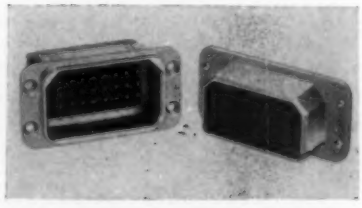
For more information—
Circle 61, inside back cover



Flexible Shaft Coupling

In manual controls, tuning, plug-in units, sub-miniaturization and low-power transmission this ½-in. dia, 1⅛-in. long flexible shaft coupling is said to permit up to 5 deg angular or 1/16-in. offset misalignment. It is reported that the component is free from backlash. Weight is ¼ oz and it will fit ¼-in. shafts. Hubs are brass, nickel plated, and the insulator is of nylon. Renbrandt, Inc., 98 Kirkland St., Cambridge 38, Mass.

For more information—
Circle 62, inside back cover



Miniature Rack-And-Panel Connectors

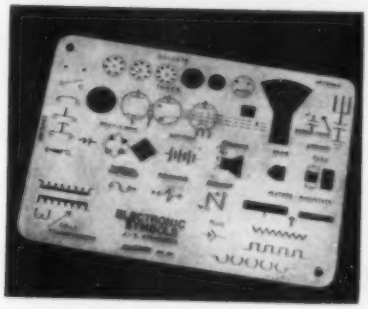
Two new rack, panel and chassis connectors in comparatively miniature sizes are described as occupying approximately 35 percent less area for rack, panel or chassis mounting than the standard series of connectors made by this company. The shell of the Type

DPA measures overall 2 x 1 x $\frac{53}{64}$ in.; the DPX, $2\frac{5}{16}$ x $1\frac{1}{8}$ x $1\frac{1}{8}$ in. Straight and 90 deg angle junction shells with integral clamps are available for the DPA type.

A corner-keying design aids polarization. The elimination of conventional insert retaining screws allows maximum insert space utilization for contacts. Chamfered lead edges of shell permits blind piloting compensation for a $\frac{1}{16}$-in. misalignment.

Contact arrangements currently available include standard 5, 10 amp and coaxials (5 amp), up to a total of 32 contacts, with various layouts available. Insulation materials used are the latest developments of high dielectric strength plastics, melamine or Diall 51-01. Material of the sturdy shell is lightweight aluminum alloy to protect the insulator. Cannon Electric Co., 3209 Humboldt St., Los Angeles 31, Calif.

For more information—
Circle 63, inside back cover



Electronic Symbols Template

A new electronic symbols template containing standard JIC symbols has been designed for the industrial electronic, television, radio and electrical fields. Made of 0.030 in. matte finish plastic, all cut-outs are milled, not punched, for precision smoothness. Overall size of the template is 7 x 5 in. Rapidesign, Inc., Box 592, Glendale, Calif.

For more information—
Circle 64, inside back cover

Reversing Drum Switch

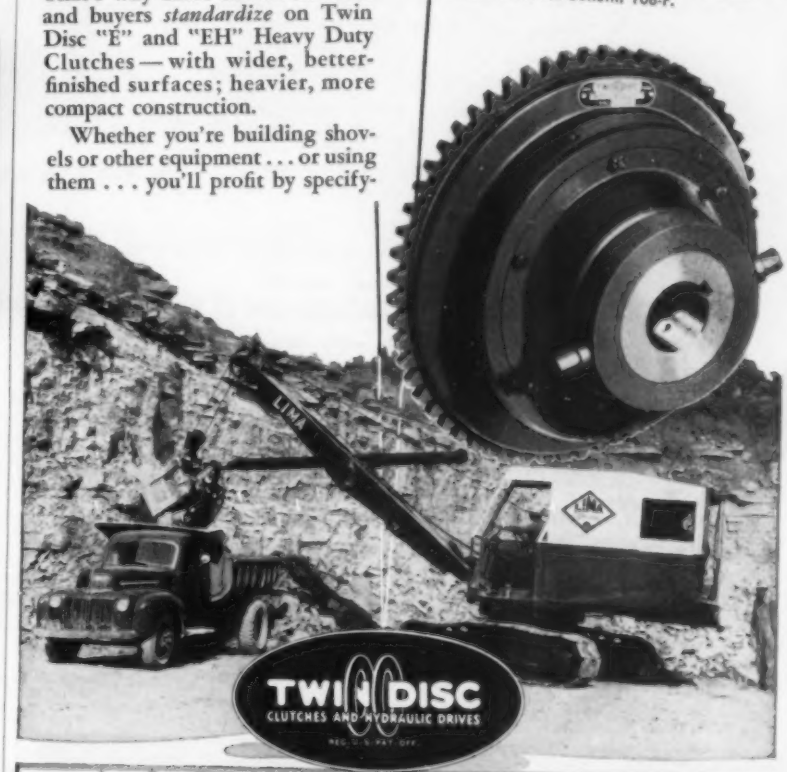
A reversing drum switch for all ratings up to 20 hp is described as suitable for use with many types of electrically-driven equipment, including conveyors, hoists, wood and metalworking machinery, pumps and processing equipment.

The unit's double-break silver con-

Crowd, hoist, swing—*crowd*, hoist, swing—millions of times a day on jobs in construction, mining, and materials handling, rugged shovels slam the horsepower of powerful engines through hard-working clutches. Jobs like this call for tough, precision clutches, built to withstand loads *beyond* rated capacities. That's why more shovel builders and buyers *standardize* on Twin Disc "E" and "EH" Heavy Duty Clutches—with wider, better-finished surfaces; heavier, more compact construction.

Whether you're building shovels or other equipment . . . or using them . . . you'll profit by specifying Twin Disc Friction or Hydraulic Drives . . . developed from 35 years of specialized experience, backed by 8 Twin Disc Factory Branches and 60 Twin Disc Parts Stations.

Lima-Hamilton Division, of Baldwin-Lima-Hamilton Corp., incorporates Twin Disc Clutches in many products, including Heavy Duty Model "E" Clutches in its Paymaster Shovels. Write for Bulletin 108-F.



TWIN DISC

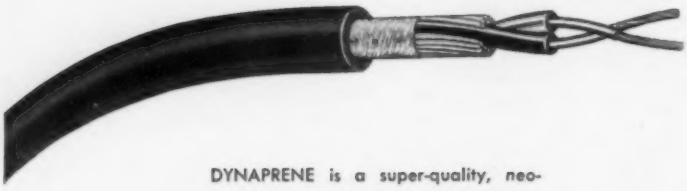
TWIN DISC CLUTCH COMPANY, Racine, Wisconsin • HYDRAULIC DIVISION, Rockford, Illinois

BRANCHES: CLEVELAND • DALLAS • DETROIT • LOS ANGELES • NEWARK • NEW ORLEANS • SEATTLE • TULSA

DYNAPRENE®

Flexible Cord

IS *MADE* TO LAST



DYNAPRENE is a super-quality, neoprene-jacketed flexible cord designed specifically to provide the greatest resistance to impact and flexing — those twin menaces to cord life.

DYNAPRENE is cured by the continuous vulcanizing process which assures a cord uniformly cured, free from deformation, and with accurately centered conductors.

DYNAPRENE is resistant to oil, moisture, gas and acid fumes and withstands the usually destructive effects of sunlight and aging. It wears longer because it is tough and far exceeds the Underwriters' minimum requirements for Types SO, SJO and SV neoprene-jacketed style cordage.

DYNAPRENE, a cord of the highest quality, can be depended upon to deliver power where and whenever it is needed.

Well Built Wires Since 1899

WHITNEY BLAKE COMPANY

New Haven 14, Connecticut

tacts are closed by positive straight line action to increase interrupting capacity and eliminate sliding or teasing and resultant wear. These drum switches are available in a NEMA Type I sheet steel enclosure with a "U"-shaped cover. Mounting holes on the bottom and back of the enclosure are provided for mounting in various locations. The reversible operating handle may be changed to operate from the front, back, or either side. Federal Products Co., 50 Paris St., Newark, N. J.

For more information—
Circle 65, inside back cover

Variable Auto-Transformer

This variable transformer, adaptable for work bench or other applications such as line voltage control for power supplies and instruments, control of heat, motor speeds, light intensity, is said to be low in cost.

The new unit has a toroidally wound variable transformer and a new brush assembly which maintains almost constant pressure from full brush to no-brush.

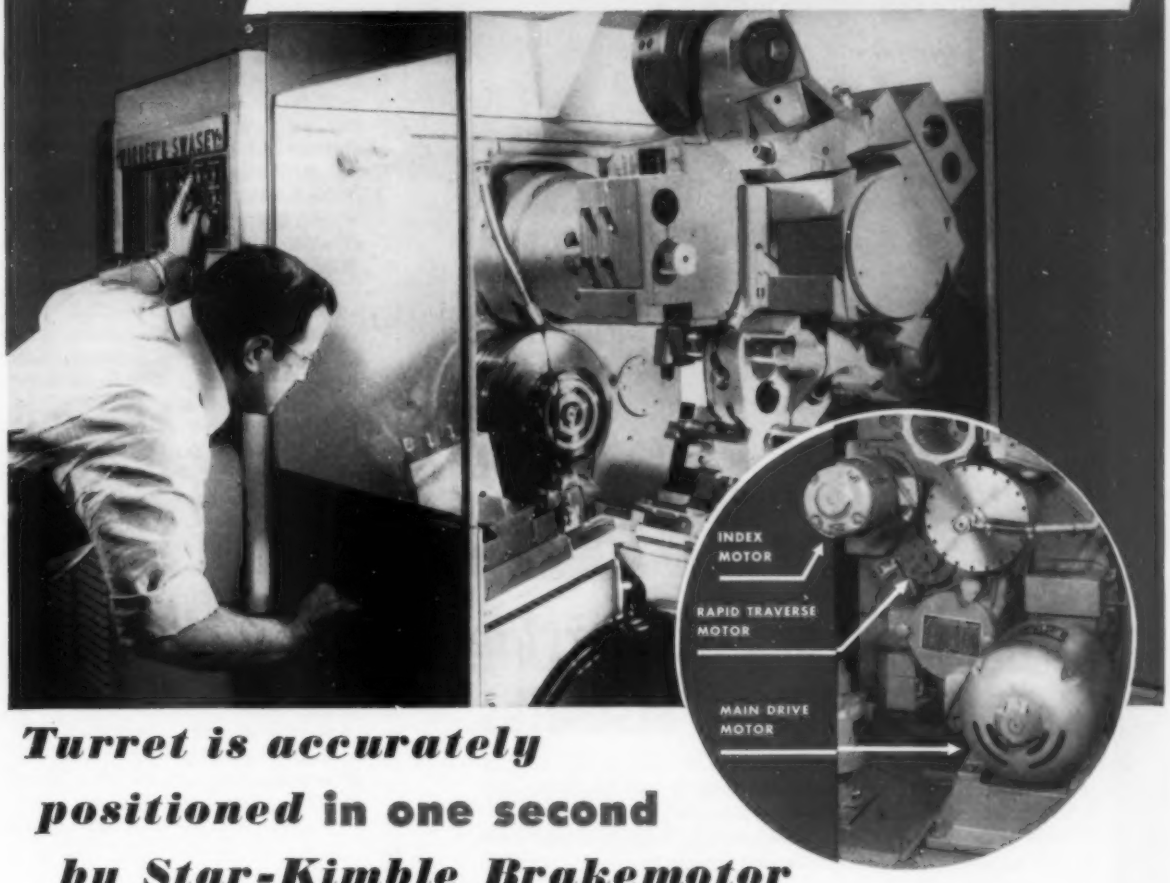
Dimensionally small and compact, the PA-3 is $6\frac{1}{2}$ x $6\frac{1}{8}$ x $6\frac{1}{2}$ in. It is equipped with jeweled pilot light, on-off switch, convenient fuse, cord, plug and receptacle. Input required is 115 v, 50-60 cycle. Output is 0 to 135 v. Maximum load rating is 0.4 kva. Standard Electrical Products Co., 2240 E. Third St., Dayton, Ohio.

For more information—
Circle 66, inside back cover

Holding Coil Switch

This holding coil switch has a built-in solenoid which holds the switch on contact until the solenoid coil circuit is externally interrupted. This circuit as well as the external single-pole, single-throw switch circuit may also be broken manually by pulling the switch knob. Besides aeronautical applications, the new switch can be used for circuit over-

On the NEW Warner & Swasey Automatic Chucking Machine



Turret is accurately positioned in one second by Star-Kimble Brakemotor

Turret of this production-speeding Warner & Swasey 2AC Machine—with turret-and-tool weight of 1250 pounds—is rotated 72° after each operation by a standard 1 hp Star-Kimble Brakemotor . . . and is accurately positioned for the next operation *within 1 second!* Fast, time-after-time precision stops of the Star-Kimble design make this possible.

FOR THE RAPID TRAVERSE, too—calling for turret-and-tool movement at 4 inches per second, with a maximum of 10 starts and stops in 45 seconds—Warner & Swasey has selected a completely special Star-Kimble 1½ hp construction designed both for this severe service and for the limited space available in the machine column.

AND FOR THE MAIN DRIVE MOTOR, which is selected by the customer, many purchasers of 2AC automatic chucking machines are specifying a 15 hp Star-Kimble dripproof squirrel-cage motor of basically standard construction, with special electrical characteristics specifically designed for this application.

These three types of motors are typical of Star-Kimble's ability to supply: standard motors for which all parts and subassemblies are carried in stock; modified types which can be economically produced in small quantities; and completely special designs in volume runs. Your inquiries on your specific requirements are invited.

Standard and special motors of all types, 1 to 125 hp; generators and motor-generator sets, 1 to 100 kw; marine motors, ½ to 125 hp.

Star-Kimble MOTOR DIVISION

MIEHLE PRINTING PRESS & MFG. CO.

211 Bloomfield Avenue — Bloomfield, New Jersey

load control, end of sequence shutoff, in annunciator systems and other devices.

Besides reducing the size and weight of conventional holding circuits, the switch is said to eliminate the wiring needed to interconnect the relay, switches, and pilot light commonly used in these circuits. Since the switch is a snap-action device, there is none of the maintenance commonly required by relay circuits. Estimated service life is in excess of 25,000 make-and-break cycles at rated load.

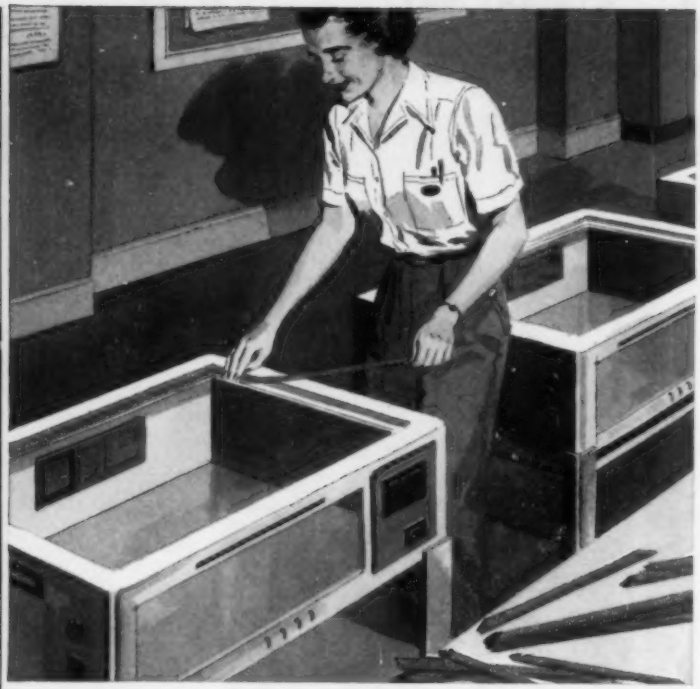
Weight is 3 oz and body diameter is $1\frac{5}{16}$ in. Overall length, including the large anodized aluminum knob, is $3\frac{3}{8}$ in. The switch mechanism is completely enclosed for reliable operation even under conditions of high humidity or salt spray. The cylindrical, anodized aluminum case is fitted with a threaded bushing for mounting in a $\frac{5}{8}$ in. dia panel hole. Knobs are available with built-in lights to indicate when the holding circuit is energized.

Present types have 240 ohm coils for 30 v, d-c operation. Contacts are rated for a 5 amp inductive load at 30 v, d-c. In order to meet the severe shock and vibration requirements of military specifications, the coil has been designed to hold the switch closed with a 1 lb load suspended from the plunger knob and with only 18 v, d-c, applied to the coil. Hetherington, Inc., Sharon Hill, Pa.

For more information—
Circle 67, inside back cover

Bearing Hanger With Faster Reverse

A two-speed bearing hanger adds compact, high speed reverse rotation to regular power take-off drives used with truck-mounted equipment. It is asserted to be especially important in winch operation, since long lengths of cable can be payed out fast and efficiently at higher speed than is possible



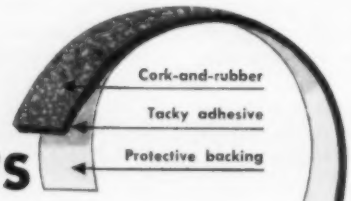
This cork-and-rubber tape seals, cushions, insulates

Makers of everything from baby incubators to diesel locomotives are finding hundreds of uses for Armstrong's DK-153 Cork-and-Rubber Tape. This versatile material helps them do the job better—saves time and money, too.

DK-153 will soak up squeaks and rattles where metal meets metal. It will skid-proof telephones and other desk-top equipment—weather-strip bus windows or parking meters. Fragile or easily marred products can be protected during shipment by applying DK-153 at all points where the unit contacts the crate or shipping case.

This springy, flexible material comes in sheets, ribbons, rolls, or die-cut shapes, in many widths and thicknesses. It is backed with pressure-sensitive adhesive and can be applied quickly and easily to any clean, dry surface.

For samples of DK-153, write on your letterhead to Armstrong Cork Company, Industrial Division, 7309 Irvin Street, Lancaster, Penna. Available for export.



ARMSTRONG'S DK-153 TAPE

with the reverse speed of regular power take-offs. A power take-off with one-speed forward plus the bearing hanger provides two-speed reversed drive rotation, while a take-off with two-speeds forward plus the bearing hanger provides four-speed reversed drive rotation.

Mounting flexibility of the bearing hanger allows it to be placed at the most convenient spot in the special equipment drive for easy installation. It can be mounted in a horizontal or vertical position, and its drive shafts can face to the front or rear of chassis, as the application requires. Either of two drive shafts can be used as the drive input shaft.

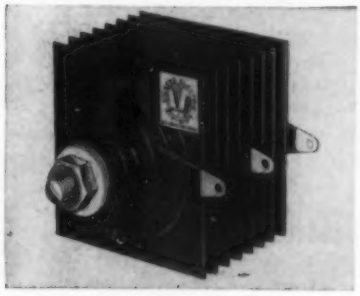
The bearing hanger is constructed with hardened steel, shaved gears, which run in oil and rotate on ball bearings. Dimensions of the bearing hanger are 12 x $9\frac{1}{16}$ x $7\frac{1}{16}$ in. It weighs 36.9 lb. Gar Wood Industries, Wayne, Michigan.

For more information—
Circle 68, inside back cover

Gasoline Engine of 2½ Hp.

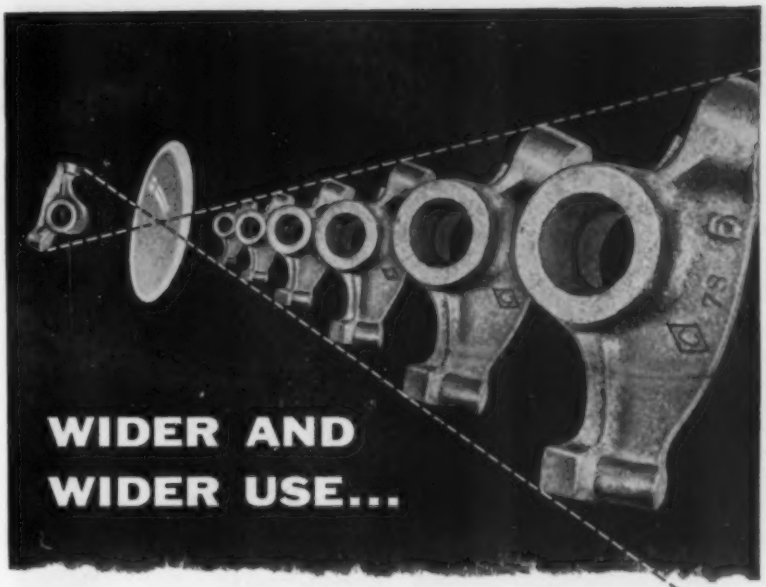
Weighing only 19 lb, this 4-cycle, vertical shaft, air-cooled engine develops 2½ hp. This power unit has a high-voltage, flywheel magneto, full-float feed, automotive type carburetion with adjustment positions for either idling or high speeds. Clinton Machine Co., Maquoketa, Iowa.

For more information—
Circle 69, inside back cover



Selenium Rectifier With 40 v Rating

This selenium rectifier, with an inverse cell rating of 40 v, is said to combine this characteristic with: (1) low leakage (2 milliamperes per sq in. average); (2) low inverse loss, with heating as a result of low inverse loss at high voltage averaging less than 5 C; (3) high dielectric quality, with ability to withstand surges up to twice the



PEARLITIC MALLEABLE CASTINGS as engineers see its many advantages

DESIGN ADAPTABILITY: Because of its good fluidity, it can be cast in thin sections and in complicated shapes.

HIGHER STRENGTH: Ultimate strengths range between 60,000 and 90,000 psi; yield strength between 40,000 and 70,000 psi.

EASILY MACHINED: Machinability index (B1112 Steel = 100) ranges between 80 and 90.

WEAR RESISTANCE: Withstands excessive wear under heavy loads at high speeds.

LOCALIZED HARDENING: Sections of the casting can be flame hardened or induction hardened before or after machining.

BEARING PROPERTIES: Good non-seizing properties in metal-to-metal contact.

FINE FINISH: Can be given a very smooth finish where desired.

You will find many applications for Pearlitic Malleable castings – particularly as a replacement for forgings, stampings and weldments – where reduced weight, less machining time, fewer assembly operations and better appearance are important production and sales considerations.

A-9277

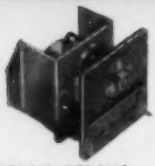
NATIONAL MALLEABLE AND STEEL CASTINGS

N M&S Co. EST. 1868

COMPANY
Cleveland 6, Ohio

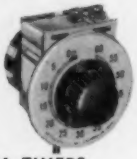
The Nation's largest independent producer of malleable and pearlitic malleable

When you measure TIME look to HAYDON*



TIME DELAY RELAYS

5900 Series: For time delay or interval timing in ranges from 0 to 10 minutes.



INTERVAL TIMERS

8006 Series: Times intervals from 60 seconds to two weeks with exactness.

ELAPSED TIME INDICATORS

5700 Series: Registers passage of time in minutes and tenths of minutes and hours with mathematical regularity.

TIMING MOTORS

Compact HAYDON Timing Motors that can be operated continuously in any position drive all HAYDON Timing Devices. HAYDON specializes in timing; engineers and builds only timing components; has the "know how" to put time to work for you.

TAKE TIME NOW to write for the name of your HAYDON Timing Specialist, and for HAYDON Catalog.

HAYDON AT TORRINGTON

A SUBSIDIARY OF GENERAL TIME CORP.

HEADQUARTERS FOR TIMING

HAYDON Manufacturing Company, Inc.
3133 ELM STREET, TORRINGTON, CONN.

☐ Send me "Electric Timing Devices" catalog.
☐ Send me name of HAYDON Timing Specialist.

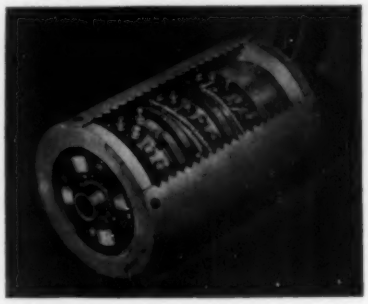
NAME_____
TITLE_____
COMPANY_____
CO. ADDRESS_____
CITY_____ ZONE___ STATE_____

*Trademark Reg. U.S. Patent Office

rated voltage. It is also said to operate in ambient temperatures up to 125 C, with no derating for 50 C.

A newly-developed, inherently stable, inorganic barrier adds substantially to the life of the rectifier, it is claimed, with inverse characteristics actually improving with use. Life tests on the rectifier are now past the 25,000 hr mark. Vickers Electric Div., 1817 Locust St., St. Louis 3, Mo.

For more information— Circle 70, inside back cover



Digitizer for Industrial Automation

A new power digitizer, capable of handling currents of 5 amp can operate summary punches, relays, hydraulic and pneumatic solenoid valves and similar equipment, directly without the need of amplifiers. Low operating torques are reported to have been achieved because of ball-bearing construction. High power capacity is achieved by using separate digitizing and power circuits within the compact digitizer unit. The power digitizer has no vacuum tubes. It has a 3.5 in. dia and a length of 5.7 in. Oerlikon Tool & Arms Corp. of America, Asheville, N. C.

For more information— Circle 71, inside back cover

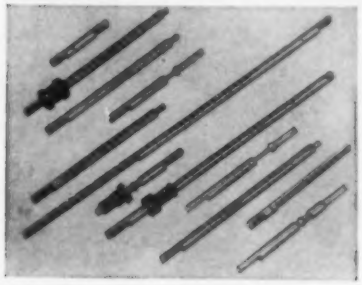
Tabletop Reproduction Machine

A low cost, tabletop, direct reproduction machine, designed for use in the engineering, drafting, and architectural fields, has an operating speed of 12 ft per min and has a printing width of 11 in. It can be used to make copies of rough sketches or finished drawings of component parts, details, and sub-assemblies, as well as specification lists, tabular listings, descriptive sketches, floor plans and elevations.

The Series 100 is a completely self-contained copying unit based on the

diazo direct copying process; it does not require any exhaust ducts, darkroom facilities, special lighting or plumbing. The machine makes positive copies directly from the original of anything drawn, written, printed or typed on ordinary translucent paper. An electrical connection with any standard 115 v circuit is all that is required for its operation. Its high speed, economy and simplicity of operation, together with its compact size, make it one of the most versatile copying units on the market. Charles Bruning Co., Inc., 4700 Montrose Ave., Chicago 41, Ill.

For more information—
Circle 72, inside back cover



Shafts and Shaft Assemblies

Plated or unplated steel shafts for electronic equipment, appliances and other assemblies are now available in production quantities and in a wide range of designs, including varied diameters on a single shaft, snap-ring grooves, "D" or double "D" flats, knurling for pressed-on plastic or fiber bushings and end-knurling for fingertip actuation. Special control-shaft assemblies, with or without cams, can be supplied ready for immediate chassis-mounting with flanged brass or steel externally-threaded bushings. Fox Products Co., 4720 N. 18 St., Philadelphia 41, Pa.

For more information—
Circle 73, inside back cover

Mill-Hardened Beryllium Copper Strip

Mill-hardened, or pretempered, beryllium copper is being introduced in strip form. This material offers many of the characteristics of regular age-hardening beryllium copper, yet requires no heat treatment.

In comparison with phosphor bronze, this alloy offers higher strength and hardness, improved fatigue resist-

Add longer life and greater economy to your processing lines . . .

with Tri-Clover Welding Fittings

Tri-Clover Butt Welding Fittings in Stainless Steel Type 304, 347, 316 and other analyses, are custom fabricated from highest quality materials by skilled craftsmen backed by years of specialized experience. Because of this quality, plus full corrosion resistance and longer life, the end result is greater economy in process line service.

Tri-Clover Zephyrweld® lightweight welding fittings **are made in tube O.D. sizes from ½″ through 24″ and 36″. Those through 4″ are annealed, pickled and passivated. Larger sizes are annealed, and are passivated on request. Available in all standard fitting types.**

Tri-Clover Schedule 5 and 10 welding fittings **are made in a full line, for use with light gauge *pipe* in sizes from ½″ through 24″ and 36″.**

Schedule 40 welding fittings are available in sizes from ½″ through 12″. Information on request.

For stainless steel welding fittings for every process need, be sure to specify *TRI-CLOVER.*

See your nearest TRI-CLOVER DISTRIBUTOR

LADISH CO.
Tri-Clover Division
KENOSHA WISCONSIN

EXPORT DIVISION:
8 So. Michigan
CHICAGO, U.S.A.
Cable:
TRICLO, CHICAGO

TRI-CLOVER
THE Complete LINE

I-154-2/3

'Diamond H' Miniature, Hermetically Sealed, Aircraft Type Relays

Shown Actual Size

HAVE A **WIDER RANGE** OF PERFORMANCE CHARACTERISTICS

IF YOU need a relay that will operate consistently under extremely critical or downright adverse conditions, there's an excellent possibility your requirements can be readily met by one of the multitude of variations possible with the basic "Diamond H" Series R relay. Originally designed to meet all requirements of USAF Spec. MIL-R-5757B, they far surpass many. They're adaptable to a wide variety of applications . . . guided missiles, jet aircraft, fire control and detection, radar, communications, high speed camera, geophysical and computer apparatus, for example.

TYPICAL PERFORMANCE CHARACTERISTICS

Vibration Resistance:	10-55 cycles at 1/16" double amplitude 55-500 cycles at 15 "G" 55-1,000 cycles at 15 "G" 55-2,000 cycles at 10 "G"
Temperature Range:	—55° to + 85°C. —65° to + 125°C. —65° to + 200°C.
Coils:	Resistances—1 ohm to 50,000 ohms Arrangements—single coil; two independent coils, either or both of which will operate unit
Insulation Resistance:	1,000 megohms at room temperature 100 megohms at 200°C.
Dielectric Strength:	450 to 1,250 V., RMS
Operating Time:	24 V. models 10 ms. or less; dropout less than 3ms.
Contacts:	30V., D.C.; 115V., A.C.; 2, 5, 7½ and 10A., resistive; 2 and 5A. inductive. Minimum 100,000 cycles life. Low interelectrode capacitance — less than 5 mmf. contacts to case; less than 2½ mmf. between contacts. Special Ratings: to 350 V., D.C., 400 MA., or other combinations including very low voltages and amperages or amperages to 20.
Operational Shock Resistance:	30, 40 and 50 "G" plus
Mechanical Shock Resistance:	up to 1,000 "G"
Mounting:	9 standard arrangements to meet all needs — plus ceramic plug-in socket.
Size:	1.6 cu. in.
Weight:	4 oz. or less

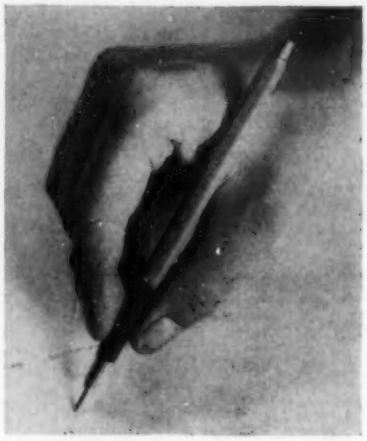
Call on "Diamond H" engineers to work with you in developing a variation to meet your specific requirements.

THE HART MANUFACTURING COMPANY
206 Bartholomew Avenue, Hartford, Connecticut

ance, approximately twice the conductivity and increased resistance to corrosion. Coil set and poor surface which were previously associated with mill-hardened beryllium copper are said to be minimized.

Available thicknesses run from 0.001 to 0.025 in., with minimum tolerances ranging from ± 0.0001 to ± 0.0004 in. depending upon thickness. On widths from ⅛ to 5 in., tolerances of ± 0.001 and ±0.002 are regularly held. The alloy is available in five tempers. Penn Precision Products, Inc., 501 Crescent Ave., Reading, Pa.

For more information—
Circle 74, inside back cover



Holder for Leads of All Diameters

This push-button holder is for use with leads of all diameters in all degrees and is guaranteed slip-proof against vertical pressure and turn-proof in all lead sharpeners and machines. The clutch, nose-piece and push-button are gold-filled. Koh-I-Noor Pencil Co., Inc., Bloomsburg, N. J.

For more information—
Circle 75, inside back cover

Metalized Polyester Film for Laminations

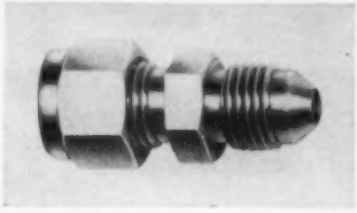
A metalized polyester film is said to have high mechanical strength, impact strength, excellent flexlife, high stiffness and good tear resistance. In addition, it exhibits high dielectric strength and a relatively low power factor. Because of its tensile quality, particularly with thin gauges like 0.00025 in. it can be used for laminations to leather, fabrics, paper and other plastic materials. Experiments indicate that these

laminations take on the surface physical characteristics of the material to which it is laminated. Since the lamination is accomplished with the colored and plated side locked to the material, the surface possesses a protective finish that is resistant to abrasion, solvents and stains.

Aside from the typical metal finishes, gold, silver and copper, a wide range of colored metalized finishes are available which have withstood 1,000 hr in Fadeometer tests.

This new film will be made available in slit-to-size rolls of 20 and 36 in. widths in the following gages: 0.00025, 0.00050, 0.001, 0.002, 0.005 and 0.0075 in. Coating Products, Englewood, N. J.

For more information—
Circle 76, inside back cover



Flare Connector For Tubing

These new flare connectors are equally satisfactory for testing or permanent installations. The threaded end conforms to AN standards. The opposite end incorporates a design said to assure torque-free, leak-proof seals at all connections. The connector is available in a complete range of sizes from $\frac{1}{8}$ to 1 in. in brass, aluminum, steel, stainless steel, Monel and other metals. Crawford Fitting Co., 884 East 140th St., Cleveland 10, Ohio.

For more information—
Circle 77, inside back cover

Soldering, Brazing, Welding Alloys For Aluminum

A line of aluminum bonding metals includes a soldering material for temperatures of 375 to 500 F, a brazing preparation for 500 to 800 F, a weld metal for 800 to 1050 F. At present, this product is available in bar shape only.

"Solbond" may be applied with an ordinary soldering iron, and flux is not and cannot be used. Aluminum alloys 24S-T, 52S-T, 61S-T, 75S-T, 2S,

LET US QUOTE ON YOUR TUBING AND FABRICATION NEEDS

Avon single wall steel tubing is successfully supplanting other types of tubing—aluminum, brass, copper and steel—with equal or improved reliability of performance and really impressive economies.

Avon's High Frequency Fusionweld process insures a much higher degree of tensile strength, greater resistance to vibration and fatigue, extreme ductility, plus greatly improved adaptability in producing the most critical tube forms—such as beading, bending, coiling, flaring, knurling, slotting, piercing, threading and swaging without cracking, tearing or checking.

Avon engineers can assist with your tubing problems and help point up cost saving advantages. Why not write, or submit blueprints for quotations.

⅜" O.D. to ¾" O.D.
PLAIN OR TERNE COATED

A few of the hundreds of Fusionweld Tubing applications

AUTOMOTIVE
Gas lines & vents
Brake lines
Hydraulic window & seat lifts
Chassis tubes
Radiator overflow
Choke controls
Oil return lines
Dip stick tubes
Oiler tubes
Automatic transmission

FARM EQUIPMENT
Hydraulic lifting devices
Support tubes
Lubrication lines
Fuel lines
Fuel manifolds

ELECTRICAL
Ceiling & wall fixtures
Lamp tubes
Heating elements
Radio & TV antennae

HEATING
Oil & gas lines
Pilot tubes
Flash tubes
Pot burner tubes
Fuel tank tubes

TOYS—FURNITURE
Scooter & wagon parts
Spacers
Pop guns
Bicycle parts
Mechanical toys
Tables
Chairs
Swings
Baby carriages, cribs, car seats and beds

MISCELLANEOUS
Umbrellas
Display boards
Panels
Conveyor oil lines
Lawn mower handles
Hose reels

AVON TUBE DIVISION

HIGBIE MANUFACTURING CO.

ROCHESTER MICHIGAN

THIS COMPREHENSIVE CATALOG MAY SAVE YOU VALUABLE TIME AND MONEY, HELP IMPROVE PRODUCTION

You'll find an efficient and economical answer to your heating needs in Chromalox Catalog 50. It includes valuable application ideas and heat calculation data you'll find useful in your work. There are more than 15,000 standard Chromalox Units—most of them stocked for immediate application to your heating jobs.

Send for Your Copy Now

1B-29A

EDWIN L. WIEGAND CO., Industrial Division
7535 THOMAS BLVD., PITTSBURGH 8, PA.

Please send me free copy of CATALOG 50

Name_____

Company_____

Street_____

City_____ Zone_____

State_____

CHROMALOX
THE BEST IN ELECTRIC HEAT

3S, may be bonded easily without upsetting the heat-treat of the aluminum.

"Brabond" is of greater strength, and may be used on all S or S-T aluminum, such as 2S, 3S, 61S-T4, or 75S-T6, as well as in the bonding of castings to castings, castings to extrusions, castings to sheet, extrusions to extrusions, and extrusions to sheet.

"Welbond" is the high-strength and high-temperature material, capable of bonding at the solution heat-treat temperature of the parent metal. Precision Electronic Research Co., Glendora, Calif.

For more information— Circle 78, inside back cover

Electrical Wiring Components

Some new lines of electrical connection equipment are featured by a duplex outlet with screwless terminals that require only that the wires be stripped to gage (molded into back of outlet) and inserted into the holes provided. Phosphor bronze spring contacts hold them in place, with holding power said to be greater than UL requires. There are no wire loops to make, no screws to run down. When necessary, wires can be removed by inserting 8d nail or other pointed instrument in center hole on either side. Back is completely insulated. Available in brown, and ivory.

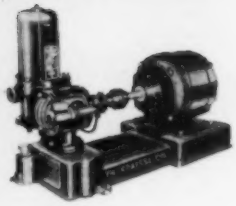
The new line of 30 amp, 3-wire receptacles, caps and cord sets have "L"-shaped slots and blades designed primarily for dryer installations. Both surface and flush receptacles have easy-to-wire, "lay-in" type pressure terminals

KRAISSL

Since 1926. In the application, design and manufacture—pumps, separators, hydraulic accessories

EQUIPMENT FOR FLUID POWER TRANSMISSION

Primary
Vacuum Pumps
•
Vacuum
Powered
Transmission
and
Low
Pressure
Air Service
•
Air
and
Liquid
Filters
•



Rotary Air Pumps for vacuum bottling

Kraissl's patented, automatic, force-free lubrication and flushing system makes these direct-drive, high-capacity pumps ideal for the special requirements of bottle-filling machinery.

Air-cooled design — or water-cooled models for heavier duty.

Class 21 roller-action pumps are recommended for handling corrosive gases and extraneous matter that might jam with closer clearances. The multi-blade design of the Class 25 pumps gives higher capacity efficiencies and is designed for applications requiring higher degree of vacuum. Where water-cooling is desired for continuous service, the water-jacketed Class 25-WJ models are recommended.

EXCLUSIVE CLASS 26 AIR FILTER

is available as an integral part of each pump up to 10 cfm — to produce oil-free discharge air and also conserve the lubricating oil.

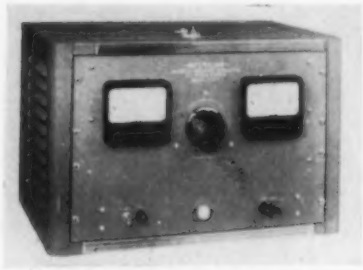
Write today for Bulletins A-1289 and A-1523

KRAISSL KRAISSL CO. Inc.
289 Williams Ave., Hackensack, N. J.

—no loose parts to be handled or misplaced.

A new duplex outlet which comes complete with box, simplifies and speeds up the installation of weatherproof outlets. Designed for surface mounting, box is of cast aluminum and plate and caps are of aluminum alloy. To install, a hole is drilled thru siding or wall into basement or other accessible inside space. Cable is fed from inside the house thru rubber grommet into box where it is held by clamp. UL-approved outlet is wired in the usual manner. Provision is made for third wire ground where desired. Cover and plate gaskets and rubber grommet seal outlet against the elements. Pass & Seymour, Inc., Syracuse 9, N. Y.

For more information—
Circle 79, inside back cover



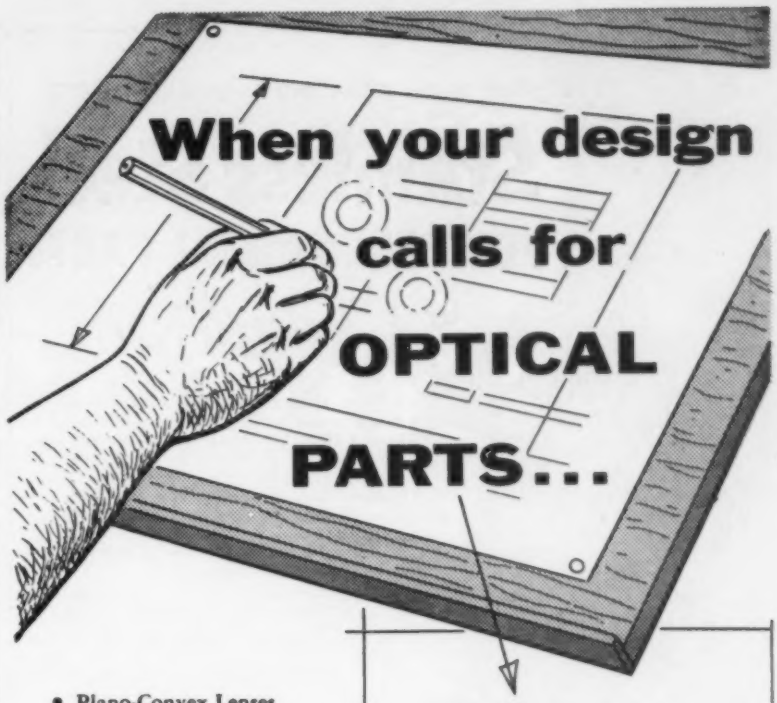
Power Supply With 1 Percent Regulation

An 0 to 32 v, 25 amp power supply has found application in laboratory testing of d-c motors, solenoids and control systems. It features a 1 percent regulation and a ripple of 1 percent rms. The unit is designed for 115 v single phase, 60 cycle a-c input and it weighs 130 lb. It is 19 in. wide x 15 in. deep x 12¾ in. high. Its a-c connection is provided with a three-prong, twist-lock connector on the rear and the d-c connection is available in the form of five-way terminals on the front and a strip on the rear. Perkin Engineering Corp., 345 Kansas St., El Segundo, Calif.

For more information—
Circle 80, inside back cover

Continuous, 30 Fpm Whiteprinting

A whiteprint machine that will reproduce translucent engineering drawings and business forms up to 42 in. wide at speeds up to 30 fpm will provide front or rear delivery and will be continuous in operation. Prints will go



- Plano-Convex Lenses (Centered)
- Double-Convex Lenses
- Double-Concave Lenses
- Plano-Cylinder Lenses
- Positive Meniscus Lenses
- Negative Meniscus Lenses
- Projection Condensers
- Achromatic Lenses
- Crown Glass Wedge Type Prisms
- Right Angle Prisms
- First Surface Reflectors —Plane
- Second Surface Reflectors —Plane
- Parabolic Reflectors
- Cylindrical Strip Lenses
- Ground Glasses
- Heat Absorbing Glass
- Retardation Plates

...get immediate delivery of samples; prompt action on volume orders for manufacture. Choose from catalog stock: hundreds of different lenses, prisms, reflectors, etc., production-run to the optical industry's highest precision standards.

WRITE for Catalog L-117 and for information on special orders. Bausch & Lomb Optical Co., 66833 St. Paul St., Rochester 2, New York.

BAUSCH & LOMB
Optical Parts

For your most exacting requirements—

Stainless Steel
POWDERED METAL PARTS

by Keystone

Bright, strong stainless steel powdered metal parts are now available from KEYSTONE in large volume for corrosion- and heat-resistant applications, and where appearance is important. Rapid tooling and elimination of machining cut costs. Close tolerances and fine finish make better products. Write for free Bulletin. Send drawing for quotation.

COMPOSITIONS Production grades are types 302B and 316. These are 18-8 chromium-nickel austenitic materials. Other standard and special stainless steel compositions also available.

Keystone CARBON COMPANY

LEADING IN POWDER METALLURGY SINCE 1927

ST. MARYS, PA.

you could make your own electricity...

But in the long run it costs less to deal with the public utility company.

In the same way, it usually costs less to have us make your coils — because we at Coto-Coil are specialists, doing the job better and faster than you can do it yourself. We have automatic time-saving equipment, and the most modern testing devices. Without trial and error, we know the best types of materials for each type of coil — thanks to nearly 40 years of coil design and manufacturing experience.

Find out how this combination can cut costs for *you*.

Coto-Coil Company, 61 Pavilion Avenue, Providence 5, R. I. New York Office: 10 East 43rd Street, New York 17, N. Y.

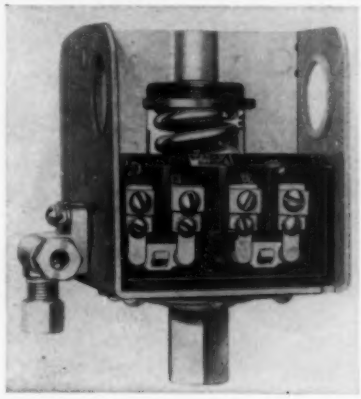
Coto PRECISION WOUND Coils

directly from feedboard through exposure and development without having to be re-handled. A new jet-type atomizer forces ammonia under pressure into a vaporizing tank, while waste is reported to be held lower than was previously considered possible.

In the printer section, an electronic speed drive permits instant changes to any speed from 8 in. to 30 fpm. A wattage stabilizer maintains constant printing speeds by compensating for voltage fluctuations within the 200-240 v range.

The dry development section has a thermostat control to maintain the temperature desired for uniform development. Vapor circulation is automatically coordinated with the machine's different speeds, and a manually operated auxiliary control provides development of all types of sensitized materials. Ozalid, Johnson City, N. Y.

For more information—
Circle 81, inside back cover



Heavy Duty Pressure Switch

This switch is designed for heavy duty applications where reliable day-after-day operation is vital. Typical applications are service station air compressors, industrial air compressors and domestic water pumps over 1 hp.

All the parts which have bearing surfaces are made entirely of stainless steel—all other operating parts are either of a non-corrosive material or are plated steel. The diaphragm, made of thin, flexible, nylon-reinforced neoprene is asserted to be practically indestructible. Special silver alloy contacts are resistant to welding and need no filing or cleaning. A positive snap action makes it impossible to "tease" the contacts.

"Straight-through" wiring is afforded by conduit openings on each

Specify

GITS *Unit* SEAL

Result:

Economy

"Economy... counts not in savings but in selection."—*Edmund Burke*

Economy through Efficiency

Gits Unit Seal proves itself in dependable performance over a wide range of operating conditions—including extra-high speed, heat and pressure applications. Operation at peak efficiency always means dollars-and-cents savings.

Economy through Adaptability and Versatility

Gits Unit Seal fits many applications as a standardized item actually carried in stock. You harness the savings of mass production to your own specific needs. Gits Unit Seal already has wide application in the following fields: Washing Machines, Disposal Units, Gear Motors, Speed Reducers, Aircraft Turbine Pumps, Accessory Drive Units, Jet Propulsion Units, Electrical Power Equipment, Automotive Accessories, Business Machines, Standard and Special Machine Tools.

Economy through Long Life

Gits Unit Seal is designed for maximum life in any recommended application. Here's the real "proof of the pudding" in saving money.

Write Today For FREE Illustrated Brochure or send us your seal problem. Our experienced engineering staff is at your service.

*Cartridge Seal . . . requiring only 25% more space than lip-type seals.

GITS BROS. MFG. CO.

1838 S. Kilbourn Avenue Chicago 23, Illinois

Consider
these outstanding features of
New Luster-on®
COBRA*

The Chromate Finish For Producing Inhibited and Lustrous Finishes on Copper, Brass or Bronze.

- Produces a permanent lustrous finish even in recessed areas.
- Stands over 100 hours standard salt spray
- Assures very long life
- Can be handled immediately after treatment cycle — no staining or finger marks
- Replenishment required only to replace dragout
- Exhaust of bath in use is optional — not required
- Excellent paint bond qualities

Specify
New Luster-on®
COBRA
for

- Inhibited and lustrous finishes on copper, brass or bronze
- Use on solid or plated copper or brass
- Cleaning and deoxidizing copper and brass parts
- Removing flux on soldered parts

Luster-on — the first in the field and still the leader

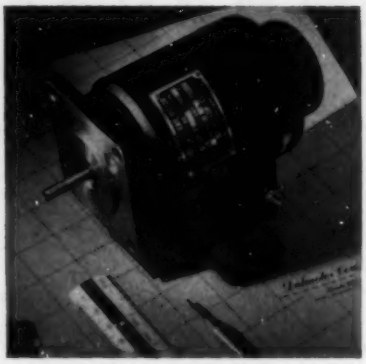
Write for full data sheets and send a part for free processing

*Patent applied for

THE *Chemical* CORPORATION
59 Waltham Ave., Springfield 9, Mass.

side of the case for a ½ or ¾-in. conduit. The operating range and differential are set at the factory according to users' specifications. However, the range can be adjusted with an ordinary screw driver, and the differential can be adjusted with a small wrench. Cutler-Hammer, Inc., 296 N. 12th St., Milwaukee 1, Wis.

For more information— Circle 82, inside back cover



Constant-Speed Motor

Capable of maintaining a constant governed speed of 7,100 rpm, ± 1.0 percent, from 24 to 30 v, dc, and with load variations of ± 30 percent, this new motor meets all military specifications for temperature, pressure, and humidity requirements in airborne equipment. The unit was engineered to meet the requirements for a speed-regulated, radar-antenna spin motor. The unit is now expected to find application in circumstances necessitating similar operating characteristics.

Radio-interference specifications are met by the design of a radio noise filter mounted directly on the motor frame. Operating on 27 v, dc, the unit is rated at ⅛ hp, and draws 6 amp, dc. It is rated for continuous duty and provides a locked-rotor torque of 9⅝ in.-lb. Total weight of the motor is 5.5 lb. Dalmotor Co, 1362 Clay St., Santa Clara, Calif.

For more information— Circle 83, inside back cover

Enameling Of Aluminum

A simple economical treatment or bath for aluminum is said to permit excellent adhesion to porcelain enamel. Prefiring is not necessary when using the "Pre-Namel 420" treatment. The bath is controlled by simple chemical tests and can be used indefinitely. Pemco Corp., manufacturer of frit, has

CARAVAN AXLES
. . . engineered for greater field performance!

CARAVAN engineers consider the facts! No matter where your product is rolling . . . in open fields, on hazardous rain-soaked roads, through extreme cold . . . you are assured of dependable performance when it is mounted on CARAVAN Axles.

Designed and engineered for load stability, CARAVAN Axles provide a massive, heavy-duty steering arm . . . extra-heavy center arm stop blocks . . . heavy-duty steering knuckle . . . and precision ground spindles. These quality engineered assemblies guarantee positive trail at high speeds as well as stability for your equipment over the roughest terrain.

For engineered superiority specify . . . CARAVAN Axles.

1910-UM *Write for literature today.*

UNITED MFG. COMPANY
741 INTERSTATE ST. • BEDFORD, OHIO

co-operated with the company sponsoring the new treatment through the various stages of its development.

In the impact test a 3½-lb weight was dropped from a height of 12 in. onto a ½-in. steel ball on the test panel. The porcelain enamel cracked only slightly, and virtually no ground coat parted from the metal.

The accelerated spalling test was used to test the resistance of the enamel system to weathering. After the edges were sheared to insure a clean interface, enameled panels were immersed in a 5 percent ammonium chloride solution. Enamel loss along the edges, after 96 hr test, was not significant. Parker Rust Proof Co., Detroit 11, Mich.

For more information—
Circle 84, inside back cover

Capacitor With Right-Angle Leads

These metal-clad, tubular capacitors with right-angle leads are new additions to the maker's subminiature line. The leads are welded to the silicone bushing stud at right angles rather than axially, which is said to make them especially suitable for printed circuit applications. Because the leads do not have to be bent during assembly, there is less chance of breakage. Calculation of bend angles has been eliminated. The right angle leads may be obtained on standard metal-clad tubular capacitor. General Electric Co, Hudson Falls, N. Y.

For more information—
Circle 85, inside back cover

Embedded Nuts Provide Sheet Metal Threads

Sharp prongs on the four corners of cadmium-plated steel nuts are embedded in sheet metal by a hammer blow or arbor press, reportedly locking the fastener securely against screw torque. A collar around the thread bites into the side of the hole in the

4 STAR TIMER

★ Low in Cost
★ No false contacts
★ No chatter
★ Quiet in operation

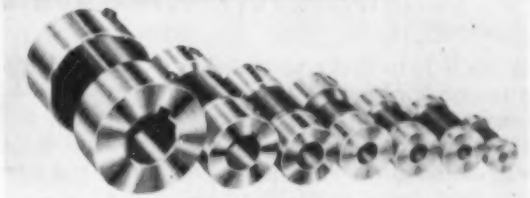
HYDROGEN SEALED

Durakool
STEEL MERCURY TIMERS

The steel-clad factory set Durakool timer-relay operates in "sealed in" hydrogen under pressure, with mercury to mercury contacts. Timing is tamperproof. Non-breakable and built for millions of contacts. Fixed time delays available from 1/6 to 20 seconds, either normally open or normally closed action.

See Telephone Directory for Local Distributor or write Durakool, Inc. Elkhart, Indiana Send for Bulletin 800

"TO TRANSMIT NOISELESSLY . . ."



5-R 4-R 3-R 2-R 1-R 0-R 00-R

specify Guardian FLEXIBLE COUPLINGS

Guardian "Dyna-Line" flexible couplings are solving drive problems in a wide variety of applications. Typical of these, with our No. 00-R from instrumentation to light pump and accessory drives, is the case history at the right.

The flex-element length, duro, compound and reinforcement all function to provide required flexibility and dampening. One-piece design means freedom from noise, lubrication and friction-drag, particularly in minor misalignment.

Our product application dept. will welcome consideration of your drive problem.

FROM OUR PRODUCT APPLICATION FILE

Case History No. 22—00

PROBLEM—A nationally advertised sewing machine required coupling to *transmit noiselessly* the 60 watt 6000 rpm of a cushion-mounted motor. The coupling must absorb misalignment to 1/16", yet provide steady power transmission without whip or backlash.

SOLUTION—Guardian Dyna-Line No. 00-R 2.25" long with standard Flex-Elements met all requirements. Length specified carried no "special length price".

Write for Catalog Page C-102 and Drive Data Form #53.

Guardian PRODUCTS CORP.
COUPLING DIVISION
Dept. IC-P, 1215 E. Second St., Michigan City, Ind.

Guardian
QUALITY IS TRUE ECONOMY

Mr. I. O. Johnson of our engineering staff, specialist in bellows applications.

THIS MAN HAS

bellows information you can use!

● He'll help make your design plans more efficient—wherever bellows or bellows assemblies are used. He'll know the kind of metal that will do the best job for you—stainless steel, brass, monel or nickel. He'll recommend the correct bellows charge—volatile liquid or gas. He'll work with you on determining the type of ends needed . . . frequency of operation . . . minimum life required and other important factors. You'll be assured of a bellows assembly exactly suited to your product plans.

There are many uses for Sylphon and Bridgeport bellows assemblies—for thermostatic devices, pressure controls, hydraulic mechanisms, expansion joints, motion transmission and other applications.

Let our engineers help you—and let our half-century of experience and ample production facilities increase your savings in time, trouble and money. Write today for full information.

SEND FOR FREE BULLETIN

Write for your free copy of an idea-filled bulletin that tells you all about metal bellows and bellows assemblies. Ask for Catalog RP-1400.

Robertshaw-Fulton

CONTROLS COMPANY

BRIDGEPORT THERMOSTAT DIVISION
BRIDGEPORT 1, CONNECTICUT

FULTON SYLPHON DIVISION
KNOXVILLE 1, TENNESSEE

sheet, anchoring the nut against reverse fall-out. Once embedded, these fasteners have been found by test to resist screw torque up to 87 in.-lb, at which point threads on the test screw stripped before the nut slipped on the aluminum sheet.

These nuts are available in five machine-screw sizes (4-40, 6-32, 8-32, 10-32, and ¼-20), and in collar lengths to fit sheet thicknesses from 0.050 in. up. Fox Products Co., 4720 N. 18th St., Philadelphia 41, Pa.

For more information—
Circle 86, inside back cover

Relays for Operational Shock

Two electronic relays of the four-pole, double-throw, continuous duty type which were specifically designed to meet guided missile requirements, should prove useful for heavy duty machinery applications. They are reported to withstand 10-G high frequency vibration at 500 cycles per second, operational shock of 50 G and will handle a 5 amp resistive contact load.

Model 814C2 is connector-mounted (illustrated) and weighs less than ½ lb. Model 644C2 is stud-mounted and has solder terminals. Weight is 0.225 lb. Both are hermetically sealed. Ambient temperature range: —55 to 71 C. U. S. Relay Co., 1744 Albion St., Los Angeles 31, Calif.

For more information—
Circle 87, inside back cover

Sponge-Rubber Pad With a Fabric Backing

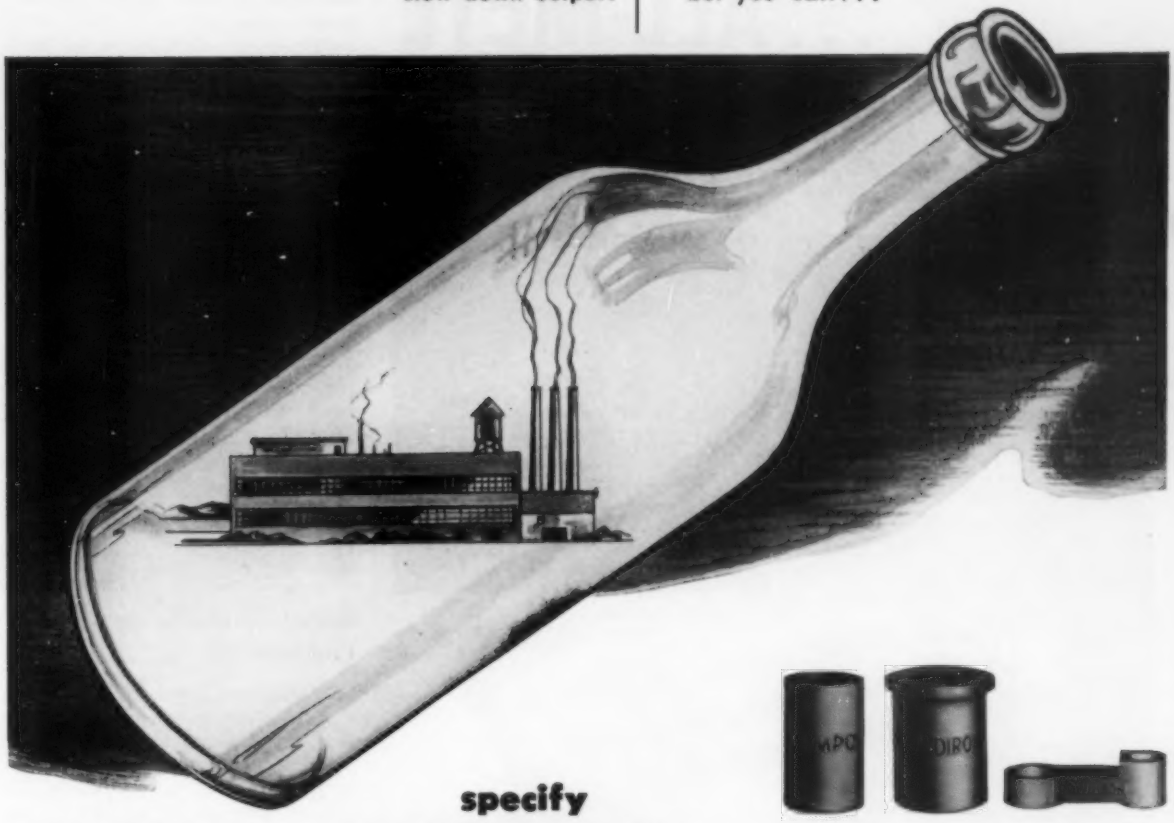
A non-staining resilient sponge-rubber compound has a fabric backing that prevents curling and provides stability. The vinyl facing protects the sponge rubber against abrasions from metal cuttings and other such abrasives and provides longer wear than ordinary rubber-skin types of sponge. It also resists oils, alkalies and

Bottlenecks on the production line . . .

because machining operations slow down output?

That's **your** problem as well as the shop's!

Sure, **you** can't speed up machining, but you **can**. . .



specify

"COMPO"® and "POWDIRON"® bearings and parts

(porous bronze) (sintered iron)

that cut down the need for machining operations.

When these **bearings** are pressed into the housing, the I.D. is right without any reaming! And **parts** are die-formed to final dimensions.

The Production Department can speed up assembly—and speed up other operations, too, by using machines and operators where they're really needed.

Sales will like customers' reactions to these bearings and parts that last for years without attention.

And if you please Production and Sales, you'll probably please **Management** too!

Want to know how these oil-retaining bearings and parts—products of Bound Brook powder metallurgy—cut product costs, stand up in service? You'll find the facts you want for yourself and your management in our folder of bulletins—just write for your copy.

Buy Bound Brook

"COMPO" • "POWDIRON" • "BOUND BROOK"

BOUND BROOK
OIL-LESS BEARING COMPANY

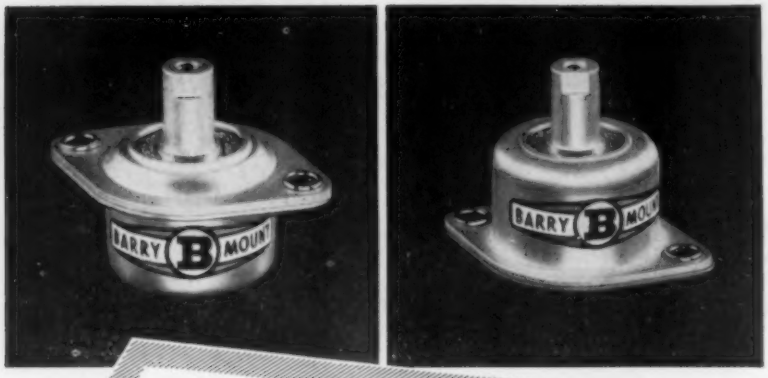
Bound Brook, N. J. **Bound Brook 9-0441**
MANUFACTURERS OF BEARINGS AND PARTS • ESTABLISHED 1883

the **NEW** *miniature*

...ALL-METL

BARRY B MOUNT

UNITS SHOWN ACTUAL SIZE



for all-temperature vibration protection of airborne equipment

These new isolators are
the latest addition to the famous
Barry ALL-METL line.
They are specifically designed to help you meet miniaturization demands under toughest environmental conditions.

Temperature range — from −60°C to +175°C
Weight — only ½ ounce per unit isolator
Height — only 1¼ " free, 25/32" bottomed
Load ratings — 0.1 to 3.0 lbs. per unit isolator
Performance — meet all relevant requirements of JAN-C-172A/MIL-C-172B
Ruggedized — to meet shock tests under specifications AN-E-19, MIL-E-5272, MIL-T-5422B, and MIL-C-172B.
Mounting styles — available in plate and cup types, as illustrated, for 2-hole or 4-hole mounting.

For complete information, ask for your free copy of the new Barry Product Bulletin 542, containing full installation and performance data. And for greatest benefits with these new isolators, let our Field Engineering Service help in the early stages of your equipment design.

THE BARRY CORP.
730 PLEASANT STREET
WATERTOWN 72, MASS.

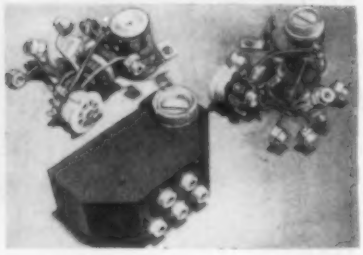
SALES REPRESENTATIVES IN ALL PRINCIPAL CITIES

British Licensee: Cementation (Muffelite), Ltd., London, England

other chemicals. This new product has been successfully used for sound deadening, shock and vibration elimination, to minimize foot fatigue and as a gasket material.

"Durapad" comes in 18 and 36 in. widths, thicknesses of ⅛ to 1 in., in any length up to 40 yd. Colors are dark green, red brown, gray and black. It cleans easily with soap and water, and solvents may be used for cleaning the surface without damage to the pad. Durkee-Atwood Co., Minneapolis 13, Minn.

For more information—
Circle 88, inside back cover



Resin for Electronic Embedment

A newly developed casting resin for producing electronic embedment such as power transformers, transistors and complete circuits has an extremely wide temperature range of usefulness, extending from 100 F to 400 F. For short periods, it can be used at 500 F.

The cured plastic has a low thermal coefficient of expansion. It is approximately the same as that of aluminum and brass. This means that even large metallic inserts can be embedded without cracking under temperature cycling. A few selected properties of Stycast 2850 GT are: flexural strength, 13,300 psi; heat distortion point, 347 F, volume resistivity, 5 x 10^{16} ohm-cm, dielectric strength, 455 v per mile. Emerson & Cuming, Inc., 869 Washington St., Canton, Mass.

For more information—
Circle 89, inside back cover

Multi-Channel Sampling Switch

This switch has a unique wiper design and selected contact material. It is d-c motor driven at any standard voltage, has a compact planetary gear reduction unit and provides sampling at rates up to about 100,000 contacts per minute. It has heavy duty soldering terminals and semi-molded contact

plates as well as individually machined contact pins. It is small in physical size and may be obtained with up to ninety shorting contacts. The unit shown has sixty contacts with alternate contacts brought to the terminals. Available with subminiature connectors in place of terminals. Similar unit is available without motor drive. General Devices, Inc., P. O. Box 253, Princeton, N. J.

For more information—
Circle 90, inside back cover

Portable Vibration Meter

A direct reading portable vibration meter measures over a frequency range of 10-250 cps, acceleration ranges of 0 to 0.03, 0 to 0.1, 0 to 0.3, 0 to 1, 0 to 3, 0 to 10 g, and peak to peak displacement ranges of 0 to 3, 0 to 10, 0 to 30, 0 to 100 and 0 to 300 mils full scale, according to the manufacturer.

The new meter consists principally of a barium titanate accelerometer, which feeds through an electronic amplifier and a copper oxide rectifier to an indicating microammeter. Unlike coil-type pick-up instruments, operation of this new meter is not affected by magnetic fields. Operating on common hearing aid batteries, the battery voltage and calibration can be easily checked by an adjustment of the selector switches on top of the instrument.

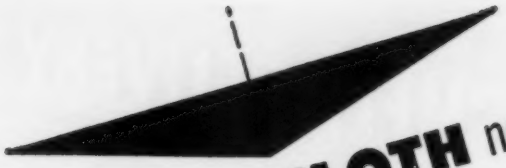
The instrument weighs about 5 lb and its over-all dimensions are 4 x 8 x 13¾ in. It is equipped with a pistol grip, trigger-type switch. General Electric Co., Schenectady 5, N. Y.

For more information—
Circle 91, inside back cover

Extruded Acrylic Sheet

These extruded "Plexiglas" sheets are priced lower than cast sheets and are suitable for outdoor as well as

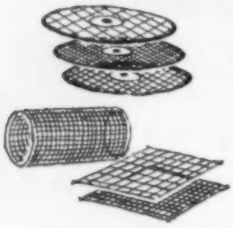
OFF SHELF DELIVERY!
New
COMPACT DESIGN
SAVES UP TO
40% SPACE!
Proven
PERFORMANCE
WITH EXTRA HIGH
SAFETY FACTOR!
T-J
Spacemaker
CYLINDERS
OIL pressure to 750—AIR to 200 P.S.I.
CIRCULAR HEADS WITH TIE RODS
SQUARE HEADS WITH TIE RODS
T-J
T-J
T-J
SPACE
SAVED
T-J SPACEMAKER ... provides additional room for adjacent equipment without sacrificing strength.
Now the sensational new T-J Spacemaker sets the pace in compact cylinder design and efficient performance!
New "Self-Aligning" adjustable oil cushion means faster acceleration and better cushion than ever before . . . New T-J Super Cushion Flexible Seals for air insure positive cushion with automatic valve action for fast return stroke.
More plus features include—heavy wall, precision honed, hard chrome plated, seamless steel body . . . leakproof cylinder head to body construction . . . heavy duty, high-tensile, hard chrome plated piston rod. Write for bulletin SM-454-2. The Tomkins-Johnson Co., Jackson, Mich.
T-J
TOMKINS-JOHNSON
RIVITORS AIR AND HYDRAULIC CYLINDERS CUTTERS CLINCHORS



your **WIRE CLOTH** needs may be in stock at **CAMBRIDGE**

Supplies of many of the most frequently used types of industrial wire cloth are kept in our warehouse ready for immediate shipment to you. And even if the type you use is not in stock, we can schedule our looms to have your material in your plant without delay. Any metal or alloy; sizes range from 20 x 250 mesh up to 4" openings...and accurate mesh count is our pride.

also **FABRICATED PARTS**



Filter leaves, strainers, sizing screens, etc. We can fabricate most any type of part you need, in any quantity. We'll work from your own prints or, if none are available, our Engineering Department will draw up prints from your description of what the part must do. Once you've O.K.'d them, we'll start production.

Why not have us quote on your next order for wire cloth in bulk or fabricated parts? Write direct or call in your Cambridge field engineer. He's listed under "Wire Cloth" in your classified telephone directory.

FREE CATALOG gives full range of wire cloth available, also shows fabrication facilities and includes valuable metallurgical data. Write for your copy today.

The Cambridge Wire Cloth Co.

WIRE CLOTH | METAL CONVEYOR BELTS | SPECIAL METAL FABRICATIONS

Department P
Cambridge 9, Maryland

OFFICES IN LEADING INDUSTRIAL AREAS

indoor applications, according to the manufacturer. Thicknesses of 0.060, 0.080, 0.100 and 0.125 in., widths of 36 and 48 in., and lengths from 48 to 96 in. are available. The material is produced in both clear transparent and white translucent form. Rohm & Haas Co., Washington Square, Philadelphia 5, Pa.

For more information—
Circle 92, inside back cover

Coupling Adjusts Rolls To Repeated Grinding

A specially designed spindle shaft coupling is being used on spindle drives between pinion stands and rolls to handle heavy horsepower and shock loads in rolling mills.

Mill operators are said to be finding that these couplings are well adapted to take care of adjustment of rolls after repeated grinding of roll surface. As the rolls are reground their outside diameter decreases and at the same time the distance between roll centers diminishes. The ability of these couplings to handle this angular difference, and at the same time maintain a smooth running, uniform peripheral speed, contributes to longer life between grinds with consequent lower resurfacing costs.

The tooth design employed makes it possible to handle misalignment previously considered excessive. Backlash is held to lubrication film requirements and all gear teeth are hardened. Ajax Flexilbe Coupling Co., Inc., Westfield, N. Y.

For more information—
Circle 93, inside back cover

Miniature Pressure-Tight Connector

This miniature electrical connector is reported to be pressure-tight with die-cast aluminum shells for maximum mechanical protection. Individual synthetic rubber "O"-rings around each contact provide pressure sealing while

MUSCLES OF OIL

that catch the plane on the flying trapeze... can work for you on the ground

Our favorite trapeze act is the one where an Air Force B-36 bomber carries its own F-84 fighter protection below its giant bomb bay, releases the fighter for reconnaissance and fighting, then picks it up in mid-air for the trip home. This aerial act is done by a giant trapeze that releases and retrieves the fighter.

One of our AEROL Actuators, driven by oil pressure, lowers and raises the trapeze and the fighter quickly, smoothly, dependably.

AEROL Actuators are designed by Cleveland Pneumatic to operate either by oil-driven pistons or by the famous high-efficiency AEROL Ball-Screw Mechanism.

We engineer and build actuators to do all sorts of unusual jobs... this trapeze-lowering actuator that uses a double telescope boom to permit rapid long extension and compact folding. Or an AEROL Ball-Screw Actuator that requires no lubrication, hence can work efficiently even in high temperatures that would cook the lubricant out of ordinary screw-mechanisms. Or an actuator that maintains its precise positioning even against the buffeting pressure of a 2500-mile gale in a model wind-tunnel.

Let us talk with you about *your* problems that might be solved by using an AEROL Actuator or Ball-Screw Mechanism. Write today for booklet E-9, and tell us your problem in some detail.

Cleveland Pneumatic Tool Company CLEVELAND 5, OHIO

TO CUSHION SHOCK...

CPT's shock absorber principle combines pneumatic and hydraulic cushioning. It can control minute vibrations or tons of impact. It is the shock absorber for the largest aircraft landing gears (CPT is the world's biggest manufacturer of landing gears), and the same principles are often adapted to finger-sized units. May we discuss with you how to take the shock out of stopping or the motion out of vibration?

DEPARTMENT E-9 • BALL-SCREW MECHANISMS • AIR-OIL IMPACT ABSORBERS • *World's Largest Manufacturer of Aircraft Landing Gears*

It has to be good....

When it can't be readily serviced—that's another WATERMAN FLOW REGULATOR STORY.

Yale & Towne install WATERMAN FLOW REGULATORS inside the lift cylinders on all their fork trucks. Only products rendering years of trouble-free service are installed where they would not be readily accessible for servicing.

WATERMAN FLOW REGULATORS can give you years of trouble-free automatic flow regulation and at the same time reduce weight, space and cost while simplifying your hydraulic circuits.

Available in a range of sizes and a variety of models to take care of your requirements.

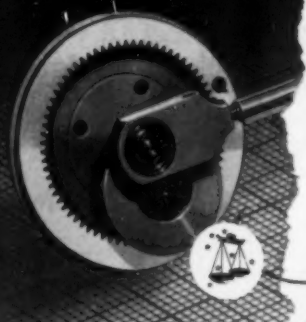
A 6,000 lb. Yale Gas Fork-Lift truck in operation.

Write for our illustrated brochure E

WATERMAN
Engineering Company
725 CUSTER AVENUE • EVANSTON, ILLINOIS

SINE-COSINE MECHANISM

INSTANTANEOUS—ACCURATE PRECISION ANGLE RESOLVER FOR ANALOG COMPUTERS



Librascope's Sine-Cosine mechanism is a precision analog computer element for converting angular rotational movements into linear sine or cosine movements. Designed for problems of changing variables involving vector components, range and bearing computations, flight computations and many other trigonometric functions. *Write for detailed catalog information.*

SPECIFICATIONS:

Positive pre-set indexing (3 position 90° apart)
Mounting: Conventional, 3 lug
Tolerances: zeros through 2 holes within .001 in.
Stroke .750 ± .0015" each side zero
Accuracy: 0.2% full scale
Weight: 2 oz.

Computers and Controls
LIBRASCOPE
A SUBSIDIARY OF GENERAL PRECISION EQUIPMENT CORPORATION
LIBRASCOPE INCORPORATED
1607 FLOWER ST., GLENDALE, CALIF.

allowing the contacts to "float", thereby precluding alignment difficulties. Air leakage is less than 1 cu in. per hr at 30 psi pressure differential.

Mineral-filled melamine insulator bodies for high dielectric and mechanical strength house five No. 20 AWG contacts (5 amp) and two No. 18 AWG contacts (7 amp). Contacts are gold plated over silver for low contact resistance, prevention of corrosion and easy soldering.

The voltage breakdown between closest contacts at sea level, 3750 v, dc; at 60,000 ft altitude, 1100 v, dc. Weight of panel-mounted receptacle, 0.6 oz; weight of cable-mounted plug, 1.5 oz. Winchester Electronics, Inc., Dept. K, Glenbrook, Conn.

For more information—Circle 94, inside back cover

Lubricant Minimizes Hydraulic System Leaks

A lubricant which is not new itself is being applied to a new job, preventing leakage in hydraulic systems. This slide and way lubricating compound is effective in reducing or preventing leakage caused by shock or vibration. The material is added to straight mineral oil or other materials used as hydraulic fluids. SW-301 is used with the hydraulic fluid in ratios ranging from 1:1 to 1:7. If lower ratios are desired the more viscous SW-601 is used. Brooks Oil Co., 934 Ridge Ave., Pittsburgh 12, Pa.

For more information—Circle 95, inside back cover

Flange-Mounted Radial Bearing

A flange-mounted radial bearing consists of a double, composition-sealed precision radial bearing and a flanged housing or adapter, designed for flush

mounting. The housing provides a secure, yet inexpensive, means of bolting the bearing in place while two locking setscrews position the bearing on the shaft.

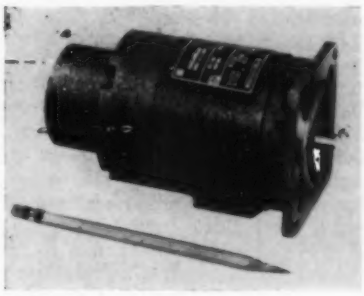
Series 6900 assemblies are recommended for medium loads and speeds up to approximately 5,000 rmp max. They are available in standard shaft sizes ranging from ¼ to 1 in. and can accommodate a limited amount of angular misalignment. Assemblies of this type can also be provided with unground bearings for less exacting applications. However, unground bearing assemblies are normally produced to order and small quantities may or may not be available from stock. Nice Ball Bearing Co., Philadelphia, Pa.

For more information—
Circle 96, inside back cover

Glass Fiber Roving For Preforms

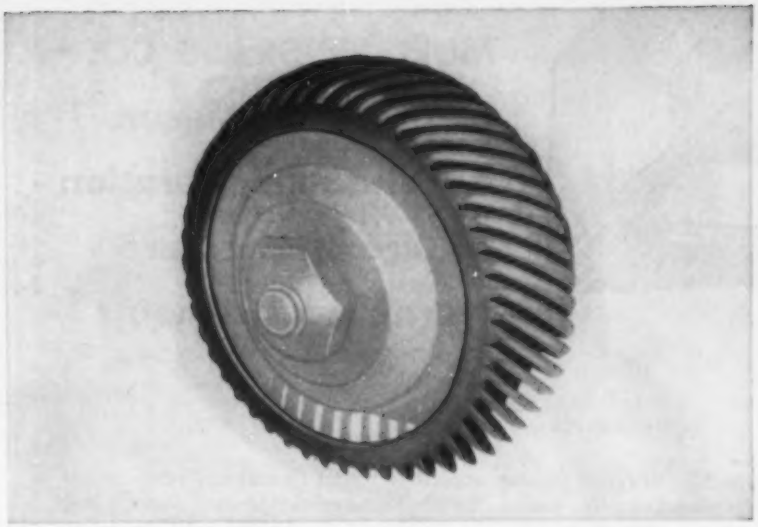
A special roving glass fiber, developed for preform molding of reinforced plastic products, has been announced. The new product utilizes a special sizing process to provide better chemical and mechanical bond between glass fibers and the actual molding resin. The roving is reported to have excellent wetting-out characteristics and adherence to contour, providing better pattern design. Pittsburgh Plate Glass Co., 632 Fort Duquesne Blvd., Pittsburgh 23, Pa.

For more information—
Circle 97, inside back cover



Miniature a-c Motor-Generator Sets

Miniature a-c motor-generator sets combine a-c synchronous motors with a-c permanent magnet generators. These units have three principal uses. They provide a source of odd frequency from standard frequency lines such as 15, 30, 90, 180 cycles. The synchronous motors are supplied with



How Flame-Plating
CUT THE COST
of Spraying Paint

This Flame-Plated turbine distributor spins at 20,000 r.p.m. in an unusual paint spraying machine to atomize paint into superfine particles. At this extreme speed, bits of foreign matter in the paint produce such a severe abrasive action that distributors previously used wore away in about 200 hours. By Flame-Plating the wearing surfaces of the distributor with wear-resistant tungsten carbide the life of this part was more than tripled—reducing replacement and machine down time costs to a minimum.

Flame-Plating is a new LINDE process for applying thin coatings of tungsten carbide on the wear surfaces of parts and many tools of most common metals where high wear resistance is required. For the full story on how you can solve your wear problems with Flame-Plating, read the new "Flame-Plating" booklet.

CLIP COUPON TODAY FOR YOUR FREE COPY

LINDE AIR PRODUCTS COMPANY, Room 308 F
A Division of Union Carbide and Carbon Corporation
30 East 42nd Street, New York 17, N. Y.

Please send me your free booklet on Flame-Plating, Form 8065

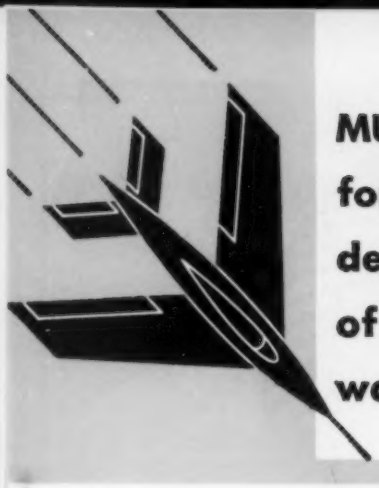
Name.....Position.....

Firm.....

Address.....

City.....State.....

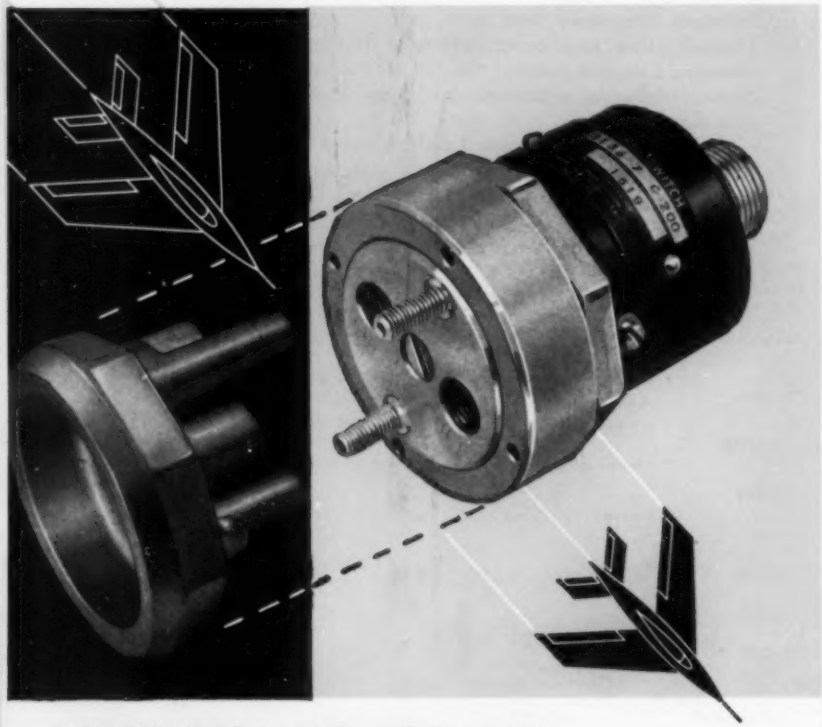
The term "Linde" is a registered trade-mark of Union Carbide and Carbon Corporation.



MUELLER BRASS CO.
forgings help insure dependable operation of aircraft pressure warning instruments

A specially designed housing, accurately forged to customer specifications by Mueller Brass Co., seals in the diaphragm of the pressure warning unit manufactured by Eclipse-Pioneer Division of Bendix Aviation Corporation in Teterboro, New Jersey. The unit, designed for installation in fuel, oil, water or alcohol lines of modern aircraft is a highly sensitive instrument that instantly warns the pilot or flight engineer of any unusually high or low fluid pressures.

All Mueller Brass Co. forgings have a dense, close-grained structure with a high tensile strength. Weight savings up to 40% are possible in the design of parts because of the close tolerances to which they can be produced. Less scrap and longer tool life result from the easy machinability of forged parts. Mueller Brass Co. is completely equipped to design parts for your products, specify alloys (including special alloys developed by our metallurgists), forge, machine, finish and plate the parts and perform all necessary assembly operations. Write today for our free illustrated 32-page forgings catalog and complete information about MBCo forged parts for your products.



MUELLER BRASS CO.
PORT HURON 17, MICHIGAN

shaft extensions for driving loads; the generator can then be used to indicate the position of the load at any instant. By fitting the unit with a rotating housing, any phase shift from 0 to 360 deg can be simulated in relation to another generator on the same unit or to an external source. Horsepower rating up to $\frac{1}{8}$ hp can be furnished, in combination with generators having an output voltage up to 200 v per 1000 rpm. Electric Indicator Co., Springdale, Conn.

For more information—
Circle 98, inside back cover

Taping Gun for Electrical Harness

It is asserted that the speed of wrapping electrical harness can be increased using plastic tape dispensed by a new gun. The gun is specifically designed for $\frac{3}{8}$-in. plastic electrical tape.

Weighing less than 20 oz with a 36-yd roll of tape in the circular magazine, the lightweight gun makes it possible to bundle the wires and cut the tape in a single easy motion taking approximately 1 sec.

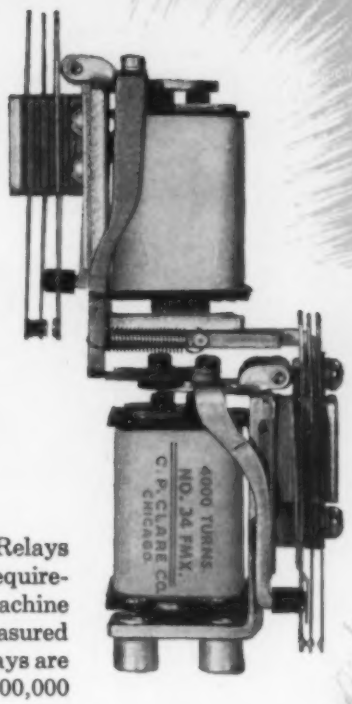
In use, the tape protruding from the end of the gun is stuck to the wires by the thumb, threaded around the bundle by the curved tip, and then cut with a touch of a thumb button. The end of the tape is pressed down to complete the wrap. With the exception of the grip and cutting button, which are molded from high-impact styrene plastic, the taping gun is of all-steel construction. Minnesota Mining and Manufacturing Co., 900 Fauquier St., St. Paul 6, Minn.

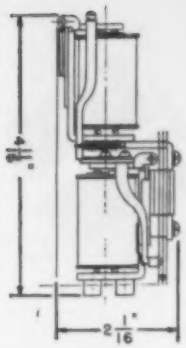
For more information—
Circle 99, inside back cover

Guaranteed Potentiometer

A potentiometer designed for applications where substantially infinite resolution and low noise under extreme vibration and acceleration are

New CLARE Type LG Relay increases life expectancy of electromechanical latching relays to millions of operations





TYPICAL CIRCUIT FUNCTIONS

1. **Hold contacts operated any length of time without consuming power.**
2. **Operate contacts over one lead; release them over another.**
3. **Act as overload relay—electrically reset from remote point when tripped.**
4. **Act as interlocking relay pair on either a-c or d-c—or on combination of both.**

CLARE Type LG Electromechanical Latching Relays were designed to meet the punishing service requirements of an internationally known business machine manufacturer. Where other such relays measured their life cycles in thousands, Type LG a-c relays are still operating satisfactorily at well over 15,000,000 operations.

The assembly shown consists of two CLARE Type GAC a-c relays with interlocking armatures. They are aligned one above the other on a common mounting bracket to save chassis space. The assembly may also consist of two Type G d-c relays, or one a-c and one d-c relay.

Relay operation is as follows:

1. When either relay is energized while the other, deenergized, relay is latched up, it will unlatch the other relay, allowing it to restore, and will latch itself up.
2. When either relay is energized while the other is already energized, it will operate its own contacts without latching up, and without affecting the other relay. It will release as soon as its coil circuit is opened. The two relays, however, can be interlocked electrically so that both coils cannot be energized at once.
3. When either relay is deenergized while the other relay is energized, the other relay will become latched up.

For full information on this new relay or for consultation on any relay problem, we invite you to contact your nearest CLARE sales engineer or write to C. P. Clare & Co., 3101 West Pratt Blvd., Chicago 45, Illinois. In Canada: Canadian Line Materials Ltd., Toronto 13, Ontario. Cable Address: CLARELAY.

Write for Bulletin 118

Specifications

MECHANICAL:

COILS:
D-c, single-wound, up to 25,000 ohms; double-wound—(concentric only) to 5000 ohms each winding.

MAGNETIC CIRCUIT:
Armature and heel piece of low-loss iron provide efficiency comparable to that of Type G or Type GAC relay. Cores of a-c coils are of laminated silicon steel. Copper shading rings fitted to pole faces to prevent armature chatter.

ARMATURES:
Single-arm. A-c relays have precision-reamed, heavy-duty armature bearings and stainless steel bearing pins.

RESIDUALS:
Fixed (plate) or adjustable (lock screw) on d-c relays.

ARMATURE LATCH:
Arm projects downward from armature of upper relay and engages latch projecting outward from armature of lower relay. Stop on lower latch prevents overthrow. Retractile spring helps restore upper armature when latch is disengaged. Latching members specially treated by most modern metallurgical methods for maximum wear resistance.

CONTACTS:
Forms A to E available. Maximum of 6 springs per relay.

WEIGHT:
Net (approx.) 1 lb. Shipping—2 lbs.

ELECTRICAL:

COIL VOLTAGE:
(Maximum) a-c, 220 volts, 20 to 120 cycles; d-c, 220 volts.

COIL RESISTANCE:
A-c, wound to number of turns specified, plus or minus 5%; d-c, resistance as specified, plus or minus 5%

COIL DISSIPATION:
(Maximum) For continuous duty: a-c, 10 va; d-c, 6 watts.

AMPERE TURNS REQUIRED:
(d-c relay) with two Form C contacts, 500.

HIPOT TEST:
Standard, 1000 volts rms.

CLARE RELAYS

FIRST IN THE INDUSTRIAL FIELD

essential carries a guarantee of 5 million revolutions at 600 rpm or less. The active element is a solid resistance track of conductive plastic which is integrally co-molded to terminals, taps and a rigid supporting phenolic insulator plastic. Standard resistance values of 2,000 to 100,000 ohms with linearity of ±1.0 percent or ±0.5 percent are available. Markite Corp., 155 Waverly Pl., New York, N. Y.

For more information—
Circle 100, inside back cover

400 Cycle Transformer

A line of miniature transformers includes units with outputs of 3 v amp and 6 v amp.

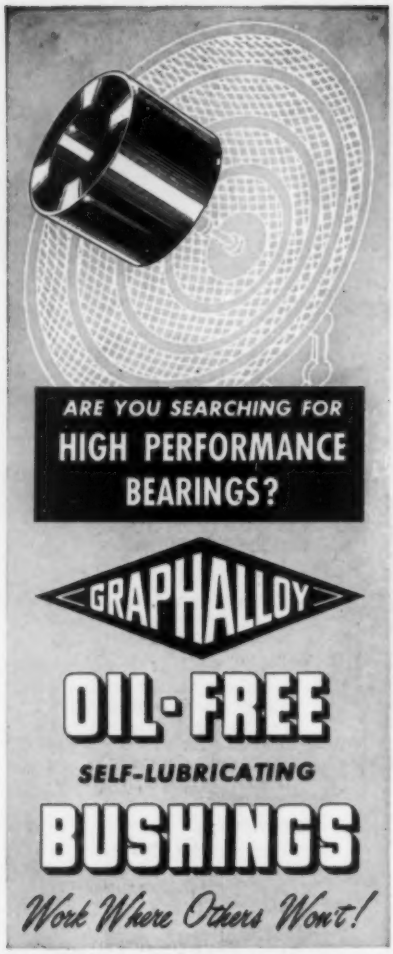
Typical of the new series is the TW-6 unit illustrated here. This miniature transformer is only 1 OD x ¾ in. high and weighs but 1½ oz. Electrical ratings are: input—115 v, 400 cycles. Power output is 6 v amp. Regulation is within 10 percent. Heat rise, 40 C, Class "A". It is hermetically sealed in a metal case to MIL-T-27 requirements. The manufacturer is prepared to supply these units in quantity. Miniature transformers with special ratings can also be obtained. Torwico Electronics, Inc., 961 Frelinghuysen Ave., Newark 5, N. J.

For more information—
Circle 101, inside back cover

Extra-High Voltage Potential Measurement

Measurement of alternating potentials up to 60 kv peak with many makes of voltmeters is possible with a new extra-high voltage divider. The unit can also serve as a potential divider with most cathode ray oscilloscopes for displaying high potential waveforms.

A voltage applied to the new divider is attenuated 10,000 to 1 with an accuracy of 2 percent, between 60 cps and 6 megacycles. Connection is made to an associated instrument with a 6 ft cable, allowing for observations at



EXCELLENT DURABILITY • CONSTANT COEFFICIENT OF FRICTION • APPLICABLE OVER A WIDE TEMPERATURE RANGE — EVEN WHERE OIL SOLIDIFIES OR CARBONIZES • OPERATE DRY, OR AT HIGH SPEEDS SUBMERGED IN WATER, GASOLINE OR OTHER LIQUIDS • EXCELLENT FOR CURRENT-CARRYING BEARINGS

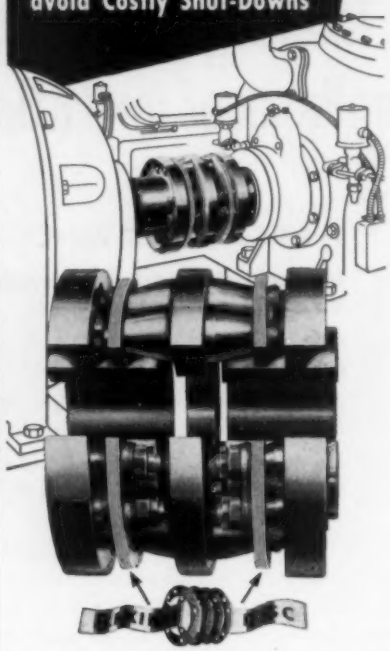
GRAPHALLOY materials are also in wide use for oil-free, self-lubricating piston rings, seal rings, thrust washers, friction discs, pump vanes, etc.

Other Graphalloy Products

For applications requiring low electrical noise, low and constant drop, high current density and minimum wear. Used for SELSYNS, DYNAMOTORS, SYNCHROS, ROTATING STRAIN GAGE pick-ups and many other applications. Brush Holders and Coin Silver Slip Rings also available.

GRAPHITE METALLIZING CORPORATION
1012 NEPPERHAN AVE. • Yonkers, New York
☐ Please send data on Graphalloy Oil-Free BUSHINGS.
☐ Send data on BRUSHES and CONTACTS.
NAME & TITLE
COMPANY
STREET
CITY ZONE STATE

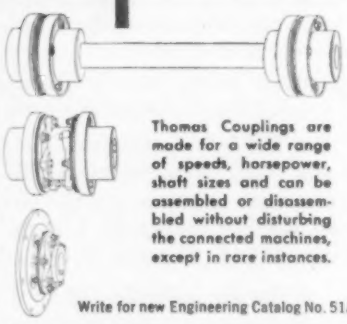
Specify THOMAS ALL METAL FLEXIBLE COUPLINGS for Power Transmission to avoid Costly Shut-Downs



Patented Flexible Disc Rings of special steel transmit the power and provide for parallel and angular misalignment as well as free end float.

DISTINCTIVE ADVANTAGES

FACTS	EXPLANATION
NO MAINTENANCE	Requires No Attention. Visual Inspection While Operating.
NO LUBRICATION	No Wearing Parts. Freedom from Shut-downs.
NO BACKLASH	No Loose Parts. All Parts Solidly Bolted.
CAN NOT "CREATE" THRUST	Free End Float under Load and Misalignment. No Rubbing Action to cause Axial Movement.
PERMANENT TORSIONAL CHARACTERISTICS	Drives Like a Solid Coupling. Elastic Constant Does Not Change. Original Balance is Maintained.

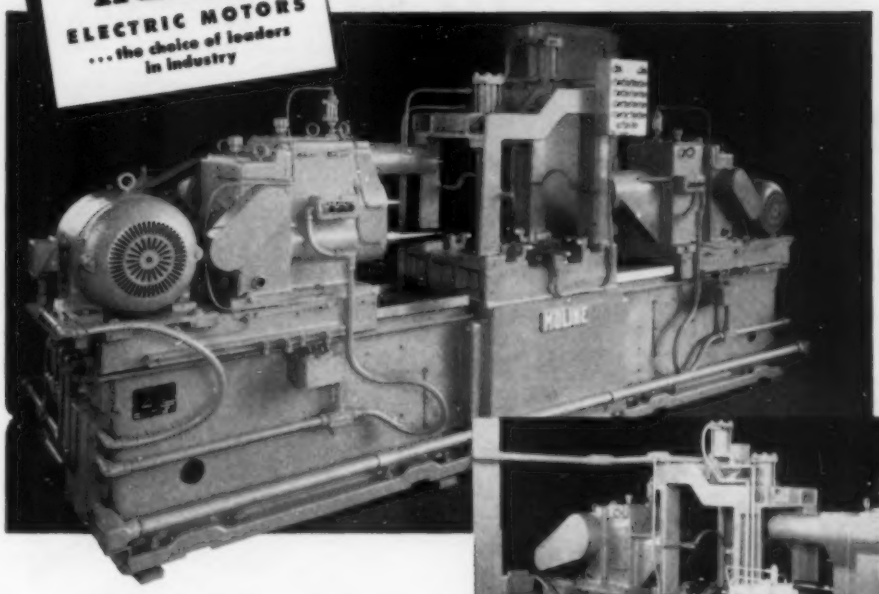


Thomas Couplings are made for a wide range of speeds, horsepower, shaft sizes and can be assembled or disassembled without disturbing the connected machines, except in rare instances.

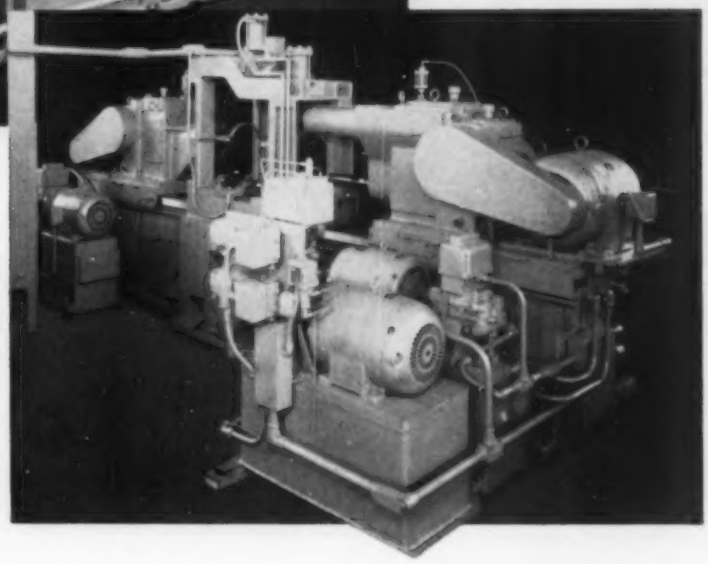
Write for new Engineering Catalog No. 51A

THOMAS FLEXIBLE COUPLING CO.
WARREN, PENNSYLVANIA, U.S.A.

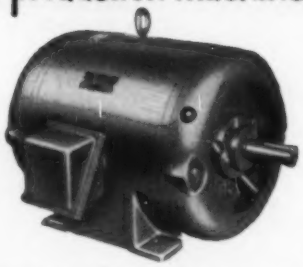
Wagner®
ELECTRIC MOTORS
...the choice of leaders in industry



Moline Tool Company No. MR 140 special boring machine for tractor clutch housings. The machine is equipped with five Wagner Type EP-1 motors, ranging from 3 to 10 hp.



Wagner
Totally Enclosed MOTORS mean less down time for production machinery



Wagner totally-enclosed fan-cooled motors are available in either steel frame or cast iron frame construction, in standard or explosion-proof types, single-speed or multi-speed, 2 phase or 3 phase, in ratings to 250 horsepower.

This Moline two-way, four-spindle boring machine bores, counterbores, faces and chamfers the end holes in tractor clutch housings. Each machine is equipped with five Wagner totally-enclosed, fan-cooled motors (Type EP-1).

The extra protection built into these Wagner Motors means less down time for production machinery. They are totally-enclosed against damage from steel filings, chips, dust, dirt, fumes and moisture. They require no maintenance other than periodic lubrication.

Whatever your requirements may be, there is a Wagner Motor to fit every need—a complete line for all current specifications, with a wide variety of enclosure types and mountings. Bulletin MU-185 gives full information.

Your nearby Wagner engineer can help you select the *right* motors for your needs. Call the nearest of our 32 branch offices, or write us.

Wagner Electric Corporation EST. 1891

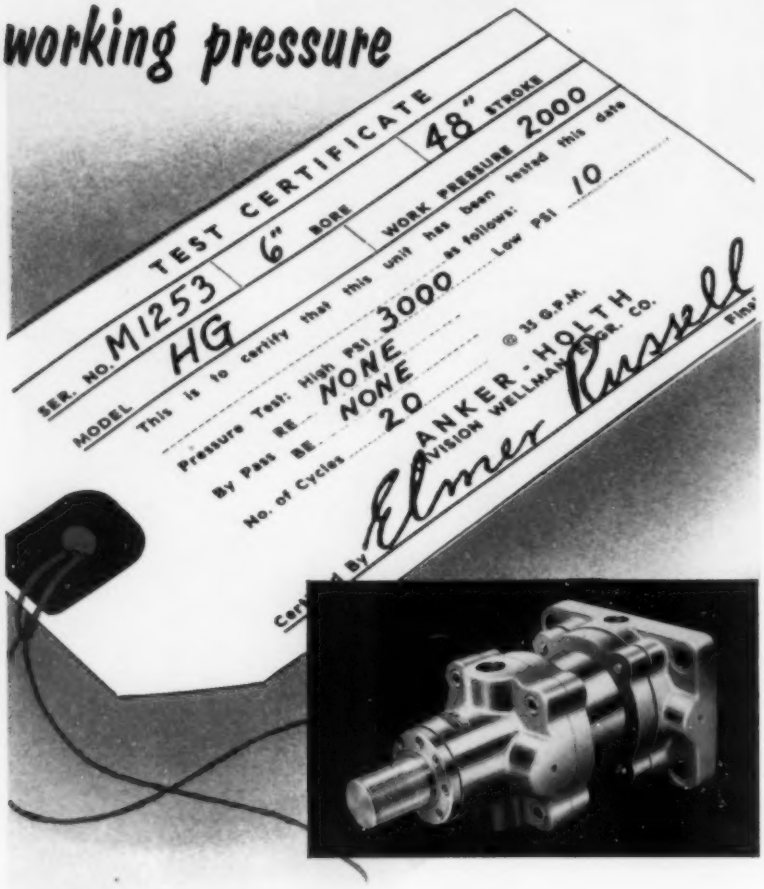
WAGNER ELECTRIC CORPORATION
6406 PLYMOUTH AVE., ST. LOUIS 14, MO., U.S.A.

BRANCHES AND DISTRIBUTORS IN ALL PRINCIPAL CITIES

ELECTRIC MOTORS
TRANSFORMERS
INDUSTRIAL BRAKES
AUTOMOTIVE BRAKE SYSTEMS—AIR AND HYDRAULIC

M54-18

Every Anker-Holth Cylinder is certified at 1½ times working pressure


TEST CERTIFICATE
SER. NO. M1253
6" BORE
48" STROKE
MODEL HG
WORK PRESSURE 2000
This is to certify that this unit has been tested this date as follows:
Pressure Test: High PSI 3000 Low PSI 10
By Pass BE NONE
By Pass BE NONE
No. of Cycles 20
@ 35 G.P.M.
ANKER-HOLTH DIVISION WELLMAN ENGR. CO.
Elmer Russell

This safeguard of dependable performance is yours when you SPECIFY ANKER-HOLTH CYLINDERS

● Each Anker-Holth Cylinder is tested at 150% of working pressure with the latest completely-filtered testing equipment. A tag such as shown above certifies to its satisfactory performance under these above-normal operating conditions.

This is another reason why it pays to specify reliable Anker-Holth Cylinders. Call or write for engineering help on your problems in power motion. ANKER-HOLTH DIVISION of The Wellman Engineering Company, Department F-5, 2723 Conner Street, Port Huron, Michigan.

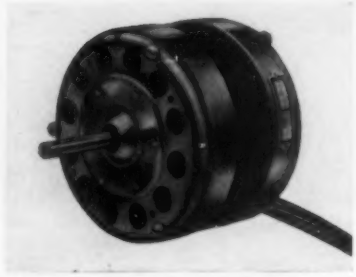
Write for bulletin on complete line of ANKER-HOLTH products

Anker-Holth
ENGINEERED CYLINDER POWER
WELLMAN
Division of THE WELLMAN ENGINEERING COMPANY

a point safely remote from a high voltage source. Input capacitance is 3.8 uuf and shunt resistance is above 10^{6} megohms.

The Model 620 can be used for extremely high impedance bridging purposes to measure down to 1 v or less when used in conjunction with sensitive types of electronic voltmeters. Ballantine Laboratories, Boonton, N. J.

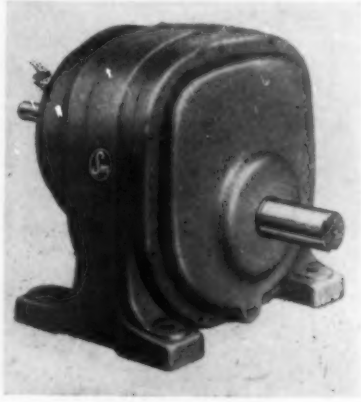
For more information—
Circle 102, inside back cover



Fhp, Shaded Pole Motor

Six-pole, shaded pole motors of $\frac{1}{8}$ to 1/50 hp ratings are being produced for use in equipment such as room air conditioners and other appliances. Either $\frac{3}{8}$ or $\frac{1}{2}$ in. dia shafts are available and rotation can be clockwise or counterclockwise. Motor can be furnished with 115 or 230 v winding. Internal windings to provide two and three-speed operation are possible. Loyd Scruggs Co., Festus, Mo.

For more information—
Circle 103, inside back cover



Easily Mounted Speed Reducer

This speed reducer is asserted to simplify application to machinery or equipment, because it can be mounted

Which is the CleCap?

. . . the one you can get pronto!

A much-used fastener style these days—socket screws. But it's surprising how scarce they can be in *the size you want* RIGHT NOW! CleCap have made it a point to make and stock *all* the popular sizes in this popular style. What's more, you can get *extra large* sizes when you need them.

We can't resist a rave about the product—CleCap's double extruded Socket Screws . . . Real *sockets* you'll admire—they're true hex, sharp cornered to give the key good "purchase", and *clean,* clear to the bottom.

"Sockets" are just one of the fastener styles CleCap makes. On any of the items cataloged below, let CleCap show you how they can make your idea of delivery a reality. If you haven't tasted CleCap service you've missed a thrill.

The Cleveland Cap Screw Company

2936 East 79th Street • Cleveland 4, Ohio • VUlcan 3-3700 TWX CV42

Warehouses: Chicago • Philadelphia • New York • Providence • Los Angeles

CLEVELAND *Top Quality* FASTENERS

Ferrous and Non-Ferrous: Bright, High Carbon and Alloy Steel Heat Treated, Brass, Silicon Bronze, Stainless Steel

Hex Head Cap Screws: ¼" to 2½" dia.
Socket Head Cap and Set Screws — Plain and Knurled: ¼" to 1½" dia. Also Flat and Button Head Styles.
Flat Head Cap Screws: ¼" to 1" dia.
Fillister Head: ¼" to 1½" dia.
Set Screws—Square Head: ¼" to 1½" dia.
Milled Studs: ¼" to 1¼" dia.
Place Bolts: ¼" to 1½" dia.
Structural Bolts to ASTM Specification A325
Tractor Bolts
Special Hot and Cold Headed Parts

Facilities to make larger diameters than listed.

Ask Your Jobber for CleCap!

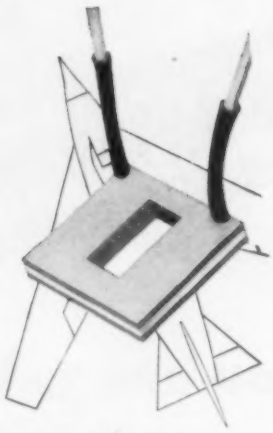
Originators of the Kaufman DOUBLE EXTRUSION Process

The Case of the
BIG STALL

SOLVED BY **WATLOW** ELECTRIC HEAT

CASE

Most military and commercial aircraft today are equipped with a "stall warning" device mounted in the leading edge of the wing, which gives an audible and visual warning to the pilot when the plane approaches a stalling attitude. The problem of preventing this device from freezing was very difficult, because of the limited amount of space available for an electric heating unit.



SOLUTION

Watlow designed the heat unit illustrated here which becomes an integral part of the stall warning device. It measures only 1.280" x 1.125" x .200" thick, with a lava core and two flexible leads, and gives sufficient heat to prevent freezing of the stall warning device. This is only one of many types of heating units which Watlow has designed for military and commercial aircraft.

WATLOW ELECTRIC MFG. CO.
Since 1922—Designers and Manufacturers of Electric Heating Units
1392 FERGUSON AVE.
SAINT LOUIS 14, MO.

WATLOW solves unusual electric heating problems every day. What is your heating problem?

is this your timing problem?

Sorry . . .
A. W. HAYDON CO.
can't help you.

Only instruction, practice, and patience can improve your score!

But . . . if your problem is PRECISION TIMING

you may save time, trouble and money by investigating what our timing engineers have done for others. Our A.C. and D.C. achievements may already include the solution of your most complex problem. Why not find out?

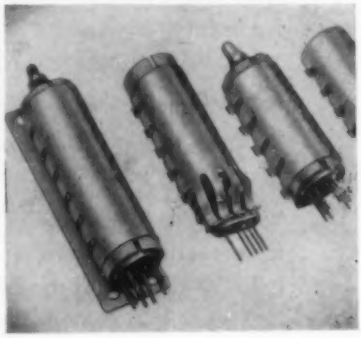
Send for latest catalog manual

The **A.W. HAYDON COMPANY**
221 NORTH ELM STREET
WATERBURY 20, CONNECTICUT
Design and Manufacture of Electrical Timing Devices

without modification on floor, wall or ceiling, with shaft horizontal or vertical. Offset shafts make possible more compact designs, permit use of larger gear diameters and require fewer parts. The drive shaft with widely spaced bearings is located close to the mounting feet and therefore minimizes torsional stress on the mounting base. Gears always run in a liberal bath of oil sealed in the gear case, which acts as the oil reservoir. A twin lubrication system is provided for triple reduction units.

Rigid case construction, achieved through correct location of ribs, keeps bearings and gears aligned. These reducers are available in a variety of mounting types—with feet or footless, face or flange mounted and in a wide range of horsepower ratings and speeds. Sterling Electric Motors, Inc., 5401 Telegraph Road, Los Angeles 22, Calif.

For more information—
Circle 104, inside back cover



Heat and Vibration Minimized

A heat-dissipating series of subminiature tube shields has been produced to meet the vibration conditions encountered in service such as missile applications. These shields have no resonances when shaken at 10 G from 0 to 2000 cycles. The shield relies upon intimate contact of the dead-soft pure silver with the bulb to conduct heat from the tube to the heat sink, and in all cases holds the tube firm in relation to the heat sink.

Any high spots existent on the tube readily embed themselves with the soft silver of the shield, preventing the movement of a tube in relation to the silver. An outer beryllium copper spring is provided, silver plated.

The manufacturer claims this clamp shield reduces bulb temperature more than any other type, resulting in a maximum temperature gradient of 5 C

per watt of plate dissipation between the bulb of the tube and the heat sink. Outside temperature of the shield runs less than ½ C per watt higher than the heat sink temperature. On request, aluminum subminiature shields can also be supplied. International Electronic Research Corp., 177 West Magnolia Blvd., Burbank, Calif.

For more information—
Circle 105, inside back cover

Ball-Bearing Connecting Rod Ends

A precision machined housing of heat-treated steel and a housing stem that is internally threaded with either right or left hand threads are used with this friction-free ball bearing rod end, which can rotate to correct misalignment up to 20 deg.

Removing and replacing the bearings in these components while reusing the housing is possible. Shields inserted on both sides of the bearing protect it against dust and abrasives.

These rod ends come in three bolthole sizes: $\frac{3}{16}$, $\frac{1}{4}$ and $\frac{3}{8}$ in. with lengths of $1\frac{1}{8}$, $1\frac{7}{16}$ and $2\frac{1}{16}$ in., respectively. Complete sets, consisting of the ball bearing ends, lock springs and rods of any desired lengths, may also be had. Avalon Machine Products, Inc., 2535 E. Imperial Highway, Los Angeles 59, Calif.

For more information—
Circle 106, inside back cover

Seals Protect Caster Raceways and Bearings

Load and thrust raceways of a line of swivel casters are protected by long-wearing, resilient seals that are said to stand up under constant swiveling and heavy loads and to keep lubricants in and dirt out. These seals, which fit snugly without binding and are formed

Would a superior coil spring solve your design problem?

I-S BeCu Springs

have an impressive record of superior performance

- ★ *High strength*
- ★ *High Conductivity*
- ★ *Uniformity*
- ★ *Reduced set and drift*
- ★ *Close tolerances*
- ★ *Long endurance life*
- ★ *Corrosion resistance*
- ★ *Stability at extreme temperatures*
- ★ *Reduced inspection and assembly costs*
- ★ *Reduced space requirements*

It is known that beryllium copper does have certain inherent advantages for some applications. But I-S exclusive heat-treating techniques in spring-forming have magnified and multiplied these advantages. From jet aircraft to refrigerators, billions of I-S BeCu springs have been used for their superior performance—and the resulting economies in cost and labor.

Call it difficult? Then call I-S . . .

From design conference—to prototype—to finished production . . . I-S' exclusive facilities and the specialized ability of our engineering staff are available to help solve your challenging problems.

For more information on BeCu Springs, write today for your free copy of our newest catalog, No 8. For electronic components, ask for No. 8-A.

Like many other leading manufacturers, you will find that these I-S facilities can make significant improvements in your manufacturing processes, and in your product. And they most likely will save you money. One thing is certain . . . it costs nothing to compare.

But it may cost considerable, not to!

Instrument Specialties CO. Inc.

234-H BERGEN BOULEVARD, LITTLE FALLS, NEW JERSEY

Telephone Little Falls 4-0280

Designed and engineered with the user in mind, O-M Cylinders embody every essential construction and mechanical feature to assure trouble-free performance and long service.

They are built of steel with bearing surfaces of bronze—precision machined with modern equipment.

Cylinder bores are honed to a fine finish, and the hi-tensile piston rods are polished to give long life and smooth performance.

Effective O-ring static seals are backed up to prevent extrusion under high pressures. All packings are self-adjusting and are carefully selected for proper usage.

A rigid inspection at the factory is your guarantee of peak performance.

O-M Cylinders fit where others won't because O-M special interlocking mechanism eliminates bulging tie rods and end caps.

Available in a full range of sizes (1½" to 8" bores) with standard, 2 to 1 or oversize rods. *14-day delivery on most sizes.*

Write today for FREE catalog and complete set of ½ and ¼-scale templates showing all cylinders and mounting brackets.

MAIL COUPON NOW!

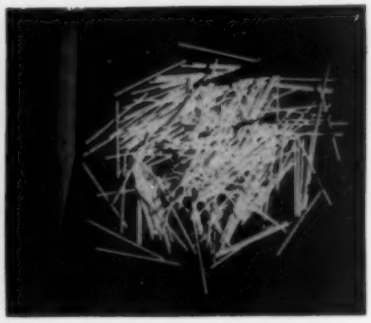
ORTMAN-MILLER MACHINE CO.
1218 150th Street - Hammond, Ind.

☐ Please have representative call
☐ Please send latest catalog

Name _____
Company _____
Address _____
City _____ Zone _____ State _____

to stay in place without squeezing out of shape or position, are available on caster models with individual load capacities ranging from 175 up to 1500 lb. Felt seals to protect the wheel bearings are available on nickel-chromium steel, forged steel, mold-on rubber, and industrial demountable wheels. Rapids-Standard Co., Inc., 342 Rapistan Building, Grand Rapids 2, Mich.

For more information—
Circle 107, inside back cover



Miniature Tubing of High Temperature Alumina

Tubes 1 in. in length with an 0.030-in. OD have been produced with two holes 0.0006-in., evenly spaced. The material is impervious, chemically inert, non-magnetic and has excellent resistance to heat shock. It can be used safely under continuous heat as high as 2000 F. It is stated that this alumina ceramic does not rust, corrode or deteriorate with time. It has superior electrical insulating characteristics.

Normal sized parts in this material have been in wide use, particularly in the electronic industry, for more than two years. Small parts have been found especially valuable as internal insulators for electron tubes, as capillaries in the chemical industry and in medical research. American Lava Corp., Chattanooga, 5, Tenn.

For more information—
Circle 108, inside back cover

Vinyl That Can Be Foamed In Place

A group of liquid vinyl compounds formulated to expand uniformly when heated at atmospheric pressure has been developed. They may be applied to flat, vertical or curved surfaces and foamed in place without sagging.

"Vynafoam" may be sprayed or brushed onto metal for sound or vibra-

engineers and PA's

This useful fact-filled catalog

YOURS FOR THE ASKING

Everything you need to know about

CURTIS UNIVERSAL JOINTS

in one convenient, file-size package.

Partial list of contents

- Sizes & styles
- Special joints
- How to specify
- Test data
- Torque & load ratings
- Keyway & Broach data
- Dimension drawings
- Engineering data
- Prices

Write today on your letterhead for your FREE copy.

TRADE MARK **CURTIS**

UNIVERSAL JOINT CO., INC.
11 BIRNIE AVENUE, SPRINGFIELD 7, MASS.
As near to you as your telephone
SINCE 1919 — EXCLUSIVELY
A MANUFACTURER OF UNIVERSAL JOINTS

technical bulletin

EEMCO

a New

TRAILING EDGE ACTUATOR

for Jet Fighters

EEMCO's new rotary actuator, Model D-665, is another example of the complete services rendered by EEMCO. Designed, developed, tested and proven in EEMCO's own plant for a leading air frame manufacturer, this new trailing edge actuator has a normal peak load of 28,000 inch-pounds and a total angular travel of 30°. Other specifications are shown below. Model D-665 can be adapted to other uses and varied specifications with a minimum of time lost in design and production.

SPECIFICATIONS ★ TYPE D-665

Weight: 25¼ pounds
Angular travel: 30° total
Normal peak load: 28,000 inch-pounds
Speed: .675 RPM with average load of 14,000 inch-pounds on 28 volt DC system (18.75 amps.)
Ultimate static load: 77,000 inch-pounds
Auxiliary power take-off
Non-jamming end stops.

Designers and producers of motors, linear and rotary actuators

Electrical Engineering and Manufacturing Corp.

4612 West Jefferson Boulevard
Los Angeles 16, California

Write for this FREE Catalog...

IT CAN HELP YOU

Lower Production Costs

Tells you how the

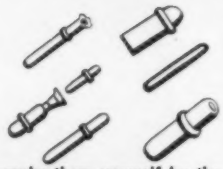
BEAD CHAIN

Economical Multi-Swage Method

can supply

TINY TUBULAR METAL PARTS LIKE THESE

for Far Less!



- far less than you can make them yourself by the screw machine or eyelet method.
- far less than you can have them made elsewhere!

If you can use high volume production, try our Multi-Swage method. We can deliver your requirements at a much faster rate . . . and at far less cost! Scrap is eliminated. Deliveries to you are dependably prompt.

We can supply you with parts that are beaded, grooved, shouldered and made with almost any metal. Diameters up ¼", lengths to 1½".

USE THIS CONVENIENT COUPON NOW! You'll get your catalog by return mail

The BEAD CHAIN MANUFACTURING CO., Inc.
92 Mountain Grove St.
Bridgeport 5, Conn.

The BEAD CHAIN MFG. CO., Inc., Bridgeport 5, Conn.
Please send me your catalog of Multi-Swage Parts.
Name.....
Title.....
Company.....
Address.....

tion deadening and heat insulation. It has been squeezed through a simple pressure gun for flowed-in-place gasketing; extrusion to form pre-cut gaskets is under investigation. The expanded thermoplastic may be heat embossed, heat sealed, after-printed or laminated to most surfaces and to itself with adhesives. Three-dimensional stenciled effects have been obtained on fabric and the proper paper by "printing" the liquid material. It also acts as an "expanding" flock adhesive.

The wet plastisol paste, which may be foamed on most strata that will withstand the required temperatures, is heated in circulating hot air at 300 to 350 F. The time required for expansion and fusion will vary anywhere from 3 to 30 min depending on temperature used, size of object and thickness applied. A square foot of expanded foam ¼ in. thick, requires ½ lb wet material. The general properties of these atmospherically blown vinyl compounds are much the same as can be found in conventional plastisols: resistance to ultra-violet light, dimensional changes, oxidation, oils, greases, most acids and solvents. Interchemical Corp., 67 West 44th St., New York 18, N. Y.

For more information—
Circle 109, inside back cover

Makes Experimental Springs and Parts

A small, hand-powered spring winding machine and a 24 in. hand-operated press brake of 8-ton capacity can be used to make small quantities of springs or parts of designs under consideration for test purposes. The press brake has a special cam lever mechanism which provides ample power for forming, blanking, piercing, drawing and trimming operations, plus a ratchet drive system which is said to multiply the power for heavy forming jobs.

This press brake will form 16 gage mild sheet steel across a 12 in. forming width as well as Inconel, brass, alumi-

num, stainless steel and other ductile materials.

The new spring winder (illustrated) is said to be ready for operation as soon as it's mounted on a bench or in a vise. Any gage wire, to $\frac{1}{8}$ in. dia, can be wound into extension, compression, torsion or flat springs. Round, flat, square or rectangular shaped stock can be formed into springs of any length.

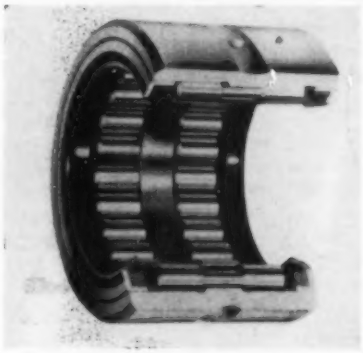
Inaccuracy in adjusting the tension control each time a spring is wound has been eliminated through the use of a unique tension clamp mechanism. Because of this, duplicate springs can be wound so that they test with the same load capacity. O'Neil-Irwin Mfg. Co., Eighth Ave., Lake City, Minn.

For more information—
Circle 110, inside back cover

Coolant Mist Uses Evaporation Principle

Evaporation-cooling principles are used by a tool-and-work coolant system that converts cutting fluids to a fine mist by means of a high-velocity air stream. The apparatus supplied includes a flow control unit in a panel enclosure (suitable for wall machine or pedestal mounting), tubing nozzles and, if required, a manifold assembly that permits application of coolant to several points at once. Air Conversion Research Corp., 3025 Northwestern Ave., Chicago, Ill.

For more information—
Circle 111, inside back cover



Sealed, Cageless Bearing

The sealed design of this bearing is said to provide dirt and lubrication sealing at little additional cost. It is made from standard stock parts without additional machining operations. It has the same cageless construction

STEARNS FIRST AGAIN!

New Magnetic Disc Brakes for Re-rated 25-100 hp Motors

First with new magnetic disc brakes for re-rated fractional hp motors . . . first for motors up to 20 hp . . . now Stearns is first to provide motor manufacturers and users with the new streamlined H-1000 and H-1200 magnetic brakes for re-rated NEMA frames in the 25-100 hp range.

New H-1000
The H-1000 is available in two maximum torque ratings, 125 lb ft and 175 lb ft. It is 2⅜ in. shorter than its Style R counter-part.

New H-1200
The H-1200 is available in four maximum torque ratings, 230 lb ft, 345 lb ft, 460 lb ft and 575 lb ft. Individual models are from 9/16 to 11/16 in. shorter than the old H-1300 series.

Both the H-1000 and H-1200 brakes are furnished with standard manual release and visible wear indicator. Torque can be set from any rating up to maximum merely by positioning a single torque adjustment nut. Both models are supplied for either horizontal and vertical motor mounting or independent floor mounting.

Power Failure Safety Feature
Each model is spring-set, solenoid-released — stops motor automatically in case of power failure. Available with either standard or dust-tight, waterproof enclosure.

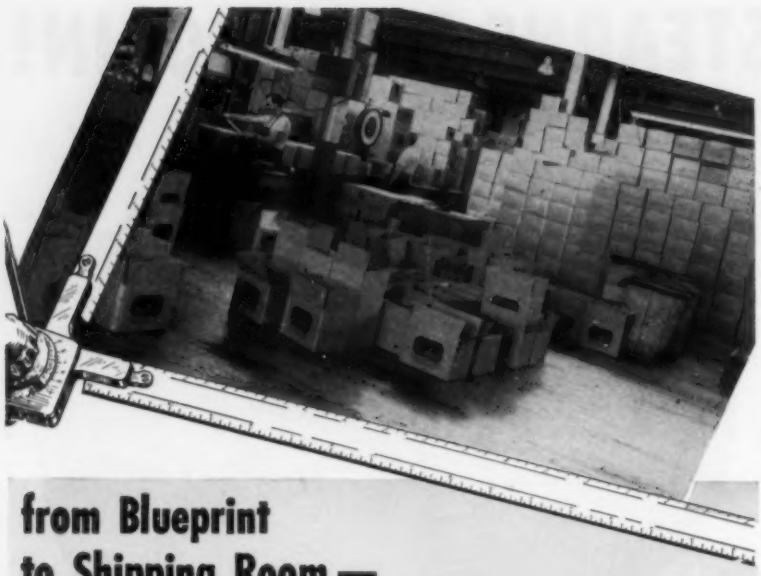
Get all the facts about this new Stearns brake. Contact your local Stearns representative or write today for new descriptive literature.

1103

MAGNETIC EQUIPMENT FOR ALL INDUSTRY

STEARNS MAGNETS

STEARNS MAGNETIC, INC., 631 S. 28th St., Milwaukee 46, Wis.



from Blueprint to Shipping Room — ACUSHNET Molded Rubber Parts are *Engineered* for Dependable Performance!

Every operation in the production of ACUSHNET precision-molded rubber parts is directly controlled by our Engineering Staff. An uncompromising Quality Control System requires rigid laboratory tests and certified approval at each stage of production before the job can be released for the next operation.

As a result, ACUSHNET parts are known throughout industry for their efficient, trouble-free performance in the countless assemblies of which they become integral members.

When your molded rubber parts require engineered precision — specify ACUSHNET.

Acushnet PROCESS COMPANY

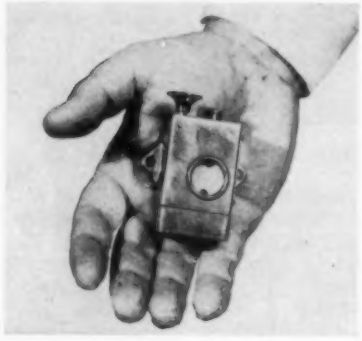
Send for your copy of the widely used "Acushnet Rubber Handbook", a comprehensive, practical rubber data reference.

Address all communications to 768 Belleville Ave., New Bedford, Mass

as standard bearings by this company, said to provide maximum load-carrying capacity in a limited radial space.

The seal consists of a metal stamping with a rubber "rind" bonded to one side. It is located in the outer race bore by means of a heavy press fit. The rubber member has an inwardly or outwardly disposed lip which has an interference fit with the shaft or inner race on which it is to operate. This interference fit on the shaft seals out foreign material and seals in the lubricant. McGill Manufacturing Co., Inc., Valparaiso, Ind.

For more information— Circle 112, inside back cover



Miniature Lubricating System

A compact lubricating system especially designed for small machine elements is said to bring the advantages of low-cost automatic lubrication to machines having minimum lubrication demands. Examples of applications include cloth cutters, coil winders and rotary indexers. All the elements of a complete lubrication system—reservoir, filter, pump, and meter—are included yet the unit measures only $2\frac{1}{4}$ x $1\frac{3}{8}$ x $1\frac{1}{2}$ in. wide.

The reservoir holds 20 cc and the pump can be adjusted to discharge a total of 0.6 cc, 0.45 cc, or 0.3 cc each time the plunger is pulled. The lubricator is of polished diecast aluminum. A one-piece, $\frac{5}{8}$ in. dia window in front of the reservoir acts as a sight gage to indicate oil level within the reservoir. Bijur Lubricating Co., Rochelle Park, N. J.

For more information— Circle 113, inside back cover

UHF Insulating Laminate

Glass-reinforced insulating sheets of thermoset styrene copolymer described as having excellent UHF electrical

78% SAVED!

BY SWITCHING FROM BRASS

TO KAISER ALUMINUM 11S-T3

A large midwestern manufacturer reports:

"Our past success with aluminum stock on many screw machine parts indicated that we could effect large savings on a 10 millimeter bottle cap we had in production.

"The saving was even more than we had estimated—permitted us to pass on to our customer a cost reduction of 78%!

"A big economy resulted from the fact that we did not have to chrome-plate the aluminum part as we did with brass because aluminum machines to a much smoother finish. And we were able to use the same machine speeds that we used with brass.

"In addition, we made substantial savings on tools, making replacements only once every two days as compared to two or three times a day with brass."

Kaiser Aluminum 11S-T3 screw machine stock is free machining; provides big material cost savings over other non-ferrous metals; can assure better parts because of its unique combination of properties.

Important suggestion for product designers! Be sure to request an alternate bid in aluminum with each bid you request in another material. This is the easy and logical way to compare both price and suitability of the materials. You'll find that aluminum usually will greatly reduce your per-piece cost and can give you a better part at the same time.

Call in a Kaiser Aluminum engineer. He'll gladly give experienced assistance with alloy selection, design considerations, production techniques. Prompt deliveries of round and hexagonal aluminum screw machine stock now being made by us and our distributors. Look for our local number in the classified telephone directory under the heading "Aluminum." Kaiser Aluminum & Chemical Sales, Inc., *General Sales Office*, Palmolive Bldg., Chicago 11, Ill.; *Executive Office*, Kaiser Bldg., Oakland 12, Calif.

Kaiser Aluminum

setting the pace—in growth, quality and service

the APEX universal joint with its exclusive, unique design and sealed, lubricant-retaining cover. For satisfactory operation under wet or dry, corrosive or abrasive conditions, or in extremes of temperatures.

CATALOG 27—contains complete information on Apex aircraft and industrial universal joints, plus helpful Application Data Sheets. Write, on your company letterhead please, for your copy.

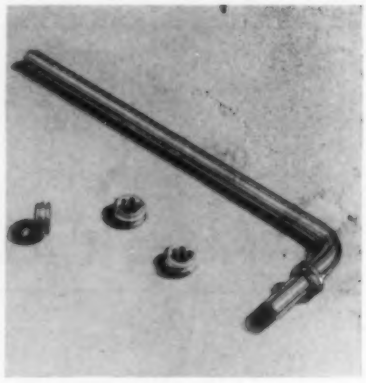
APEX universal joints

THE APEX MACHINE & TOOL COMPANY
1039 South Patterson Blvd. • Dayton 2, Ohio

properties, high impact strength and good machinability have been announced.

"Rexolite 2101" is produced from a cross-lined copolymer of styrene, and has electrical properties which are asserted to surpass those of thermosetting glass laminates, and to equal or surpass those of glass—reinforced tetrafluorethylene. Rex Corp., Hayward Road, West Acton, Mass.

For more information—
Circle 114, inside back cover



Multiple Spline Socket Screw

A new multiple spline socket set screw, designed for guided missile assembly, has just been announced. The socket is broached all the way through, enabling the screw to be wrenched from either end with equal ease. This feature is said to help promote rapid assembly, also. The screws can be fed from an automatic feed line with either end up and still be handled by automatic assembly methods.

The new socket screw, (or locking ring), is made at present only in No. 8, 0.072 in. size, with cadmium plating, but it can be furnished in other diameters and lengths as required. The Bristol Co., Waterbury 20, Conn.

For more information—
Circle 115, inside back cover

Hermetic Seals for Switches and Shafts

These seals replace the mounting nut used in front of a panel and seal out moisture, dust and combustible vapors. The seal consists of a grooved nut to which is molded a silicone rubber boat. Sealing is accomplished by a gasket-rib, which seats firmly against the panel, and two "O"-ribs which

form a double seal against the shaft. This design prevents backlash, eliminated by using a relatively hard rubber and relatively light pressure against the shaft.

Factory pre-lubrication of the well between the two shaft "O"-ribs permits the seal to function at intermittent speeds up to 1,000 rpm. The silicone rubber will operate at temperatures from —67 F to 500 F. A low temperature version functions at temperatures down to —110 F.

Present models fit $\frac{1}{4}$ in. shafts and a $\frac{3}{8}$-32 threaded bushing. Other sizes and bushing threads are available on special order. Automatic & Precision Mfg. Co., 252 Hawthorne Ave., Yonkers 5, N. Y.

For more information—
Circle 116, inside back cover

Lock Box for Coin Machines

A lock box for protecting revenue in all types of coin-operated equipment has a four-way lock with registered keys. An automatic locking device is said to prevent tampering with revenue accumulating in the box. Johnson Fare Box Co., 4619 N. Ravenswood Ave., Chicago 40, Ill.

For more information—
Circle 117, inside back cover

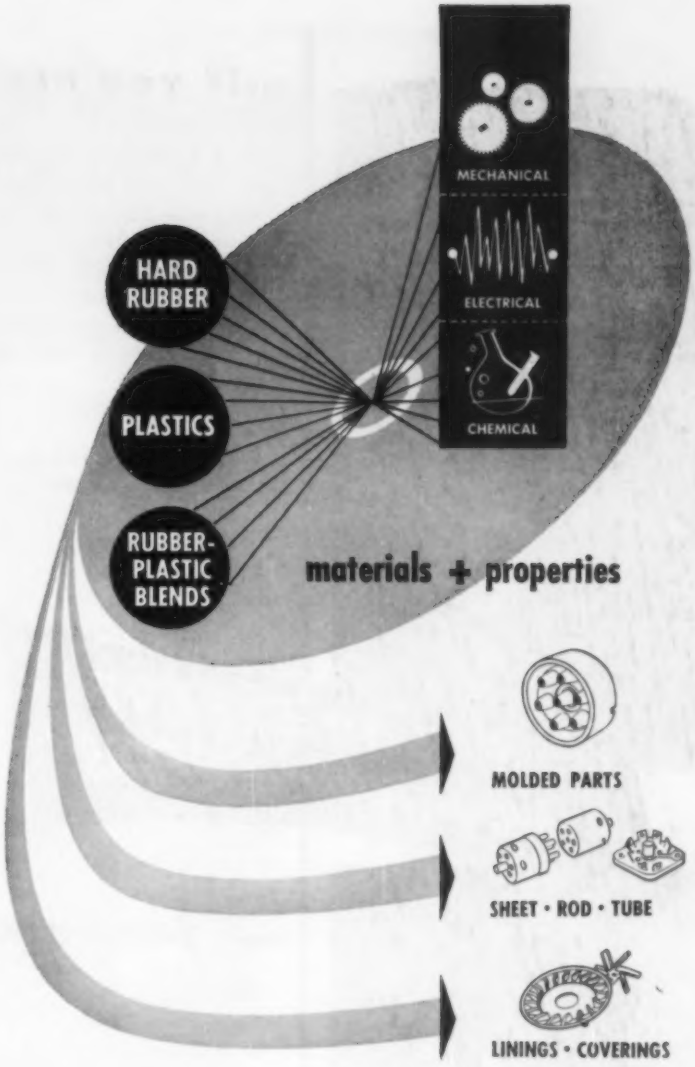
Free-Running, Reusable, Self-Locking Nuts

Serrated, hardened teeth on the face of this all-metal nut provide positive locking action. They are hardened and available in all machine screw sizes. Jacobson Mfg. Co., Inc., Kenilworth, N. J.

For more information—
Circle 118, inside back cover

Flexible Engraving Stock For Nameplates

Many applications exist where a flexible, non-breakable material for permanent identification by engraving is required. Nameplates, strips, panels have to be either bent or formed, depending on the shape of the object to which they are to be attached. A laminated plastic has been introduced which is flexible and which is said to have other unusual characteristics. It will not break because of its flexibility. It is scratch, weather and stain-resistant. It is tough, but not brittle,



ace® is not just one material

Ace means *tailor-made* rubber and plastic materials . . . with mechanical, electrical and chemical properties carefully blended to give you the *one* best material and most economical production methods for your designs. Hundreds of Ace rubber and plastic compounds to choose from—plus many unusual materials like Ace-Tex pyrobitumens and Ace-Hide rubber-plastic blends. Among world's largest molding, extruding, fabricating facilities.

80-Page Ace Rubber and Plastics Handbook Free to Design Engineers. Write today.

ACE rubber and plastic products

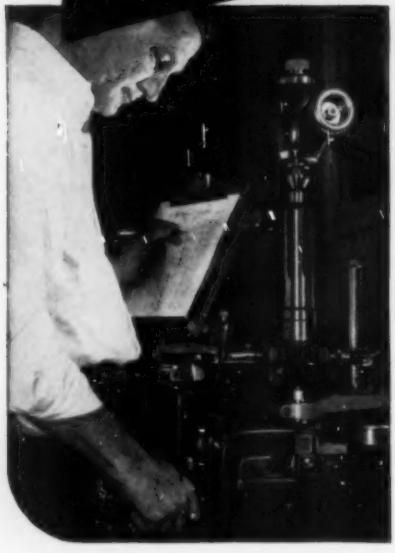
AMERICAN HARD RUBBER COMPANY
93 WORTH STREET • NEW YORK 13, N. Y.

...if you are

If you know gearmaking, you will be the first to agree that production of high precision, heat treated, automotive type GEARS requires a major capital investment in metallurgical, processing, testing, checking, inspecting and engineering facilities.

Fairfield has these facilities, plus expert "know how" in making gears EFFICIENTLY and ECONOMICALLY.

Are you an EXPERT in making GEARS?



...if you are not

Whether you are a "gear expert" or not, we believe it will pay you to check with FAIRFIELD on your current and future requirements for gears. Fairfield is one of America's largest independent producers of fine gears *made to order* for all kinds of modern machinery. *Your inquiry will receive prompt attention.*

Fine Gears Made to Order

SPIRAL BEVEL • STRAIGHT BEVEL • HYPOID • HERRINGBONE • HELICAL • DIFFERENTIALS • SPUR • WORMS AND WORM GEARS

Fairfield MANUFACTURING COMPANY

2305 So. Concord Road

Lafayette, Indiana

Ask for a copy of this illustrated bulletin.

and can be bent by hand to any shape.

Being a sandwich material, "Gravoflex" is ideal for engraving with the help of any pantograph machine. Lettering cut through the top layer will stand out permanently on a contrasting background. No paint is required and the marking will not be distorted by bending or forming. The material can also be stamped or embossed and it can be cut with scissors, paper cutter or metal shear. Edges will not chip and do not need bevelling. It can be nailed without predrilling, and can also be stitched or stapled.

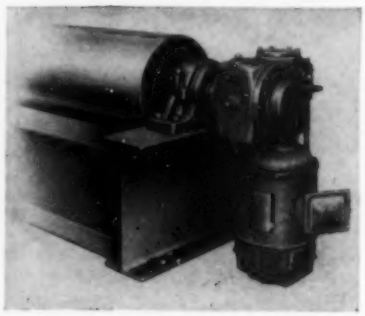
Gravoflex is available in sheets, strips or cut name plates in various thicknesses: $\frac{1}{32}$, $\frac{1}{16}$, or $\frac{1}{8}$ in. The colors are black surface with white core, white surface with red core. Hermes Plastics, Inc., 13-19 University Pl., New York 3, N. Y.

For more information— Circle 119, inside back cover

Printed Circuit Card Receptacles

The number of contacts on these circuit cards can be up to 15. Wire connector tabs in Series 3370 can extend from the right, left, or bottom of connector or in combinations of right, left, and bottom as desired. Contacts are made of beryllium copper with plating of gold over silver. HHB No. 3371 is available with terminals at bottom only for card thickness of $\frac{1}{16}$, $\frac{1}{8}$, and $\frac{1}{4}$ in. Nominal creep is of $\frac{3}{32}$ in. H. H. Buggie, Inc., Toledo 4, Ohio.

For more information— Circle 120, inside back cover



Floating Gearmotor

This compact gear and motor unit for conveyors, run-out tables and other machinery mount directly on the driven shaft. There can be no misalignment between the power unit and driven shaft as the power unit becomes an

McLouth STAINLESS Steel

High quality stainless sheet and strip steel . . . for the product you make today and the product you plan for tomorrow.

McLouth Steel Corporation
DETROIT, MICHIGAN
Manufacturers of Stainless and Carbon Steels

J-M Uneepac automatic ring packing installed in Polished Rod Lubricator-Stuffing Box manufactured by Muskogee IronWorks, Inc., Muskogee, Okla.

Equipment designers of Muskogee Iron Works report:

"Greatly increased packing life... Uneepac guards against pressure damage"

FOR THEIR NEW LUBRICATOR-STUFFING BOXES, design engineers of Muskogee Iron Works needed a packing with long service life as well as foolproof operation. Uneepac, the Johns-Manville automatic ring packing, fully met both of these requirements and contributed to the success and acceptance which the equipment has encountered.

In this application, Uneepac protects itself against damage by excessive gland pressure. The lips of each ring are guarded by the projecting portion of the Uneepac Center section. As a result, far greater service life and reliability is obtainable in this application than with other types of packings.

Uneepac offers many other important advantages for use in pump rods and plungers, compressors and similar equipment. Seals effectively in a minimum of space. Operates with minimum friction. Has excellent pressure sensitivity. Uneepac provides trouble-free operation because each ring positions itself diametrically as well as vertically. Header or follower rings are not always required because each Uneepac ring is a complete, self-protected unit.

To learn how Uneepac may aid your new equipment design, too, write for booklet PK-58A. Just address Johns-Manville, Box 60, New York 16, N. Y. In Canada, 199 Bay St., Toronto 1, Ontario.

JM PRODUCTS

Johns-Manville PACKINGS & GASKETS

integral part of the driven shaft. A simple torque arm prevents the gear unit from rotating. The unit can be mounted in almost any location or position. The right-angle worm and worm gear arrangement permits the entire unit to nestle close to the driven machine.

Gearing is said to be proportioned for 300 percent peak loading over normal ratings. Housing construction is cast steel or cast iron as required. Output speeds range from 8 to 800 rpm with integral electric motors ranging from 1 to 15 hp. Philadelphia Gear Works, Erie Ave. and G St., Philadelphia 34, Pa.

For more information—
Circle 121, inside back cover

Plastic Air Hose

Small diameter plastic air hose for use with pneumatic tools has been announced that is not only lighter and more flexible, but is flame and abrasion resistant as well. The hose is colored a bright red to permit easy identification of power air lines.

This plastic hose weighs 8.8 lb per 100 ft in the $\frac{1}{4}$ in. size. It allows lighter pneumatic tools to be used in place of heavier electric ones. It also saves cost of manual lubrication of tools by allowing the use of line oilers.

The $\frac{1}{4}$ in. ID tubing has a $\frac{1}{8}$ in. wall. The $\frac{3}{8}$ in. ID hose has a $\frac{3}{16}$ in. wall thickness. Boston Woven Hose & Rubber Co., Box 1071, Boston 3, Mass.

For more information—
Circle 122, inside back cover

Meter for All Types Of Overloads

This loadmeter is adaptable to most types of motor-driven equipment. Originally introduced to detect effects of tool dulling, this model can now detect any type of overload.

Calibration can be accomplished by

Specify **WHERE PRECISE MEASUREMENT OF TIME IS ESSENTIAL . . .**

Cramer RUNNING TIME METERS

"The Cramer running time meter plays an extremely important part in our equipment . . . ," reports R-C Scientific Instrument Company, Inc., Playa Del Rey, California, manufacturers of high-quality radiation detection instruments.

"The *Scintiscaler* shown here is designed for alpha, beta or gamma counting interchangeably. The quoted accuracy of our apparatus is based on a statistical formula for computing the probable error in sampling a series of pulses randomly spaced in time. Since no allowance is made in this formula for the running time meter, it must be extremely accurate. *We've used Cramer devices on all our scalers for the past five years with no failures.*"

Regardless of application or type of timing device needed, it will pay you to consult the R. W. Cramer Company, *specialists in time control.* An experienced engineering staff is available to help you solve your timing problems.

Running time meter with reset feature for flush panel mounting. Complete line of time control equipment available to fit every installation requirement.

Cramer TIMING DEVICES

SPECIALISTS IN TIME CONTROL

The R. W. CRAMER CO., Inc.

BOX 7, CENTERBROOK, CONNECTICUT

BIG NEWS
in
SPEED CONTROL
SPECON

SPECON—an original design principle—available in electrical, mechanical, and hydraulic models now provides industry with infinite speed range and control previously unattainable. SPECON drives have proved superior in many applications including winding, extruding, and drawing installations. Rugged design incorporating proven components assures maximum dependability.

FAIRCHILD SPEED CONTROL ENGINEERS WILL GLADLY FURNISH DETAILED INFORMATION ON THESE VERSATILE CONTROLS.
Write us Today—

ENGINE AND AIRPLANE CORPORATION
FAIRCHILD
Speed Control Division
Wickliffe, Ohio

new designs on the board?

GRC TINY MOLDED
NYLON PARTS
may be the difference between "problems" and profits!

Gries' unique single cavity molding facilities are *flexible*—provide the practical answer to countless problems of product design and improvement. No matter how tiny, or how intricate, GRC molds nylon parts to meet your exact specifications, with precise tolerances and uniform quality. And, because GRC methods are completely automatic, costs are surprisingly low—GRC tiny nylon parts are produced completely trimmed and ready for use, in one high-speed, money-saving operation!

Write today for Bulletin and Samples.

Send prints for quotation.

GRC MOLDS ALL THERMOPLASTICS SWIFTLY, DEPENDABLY, ECONOMICALLY!

Automatic Continuous and Individual Inserts! Single Parts!

Quick deliveries on quantities of 25,000 to millions.

NO SIZE TOO SMALL!
MAXIMUM SIZE .025 oz.—1" long
NO MINIMUM SIZE!

LOW MOLD COSTS!

GRC
GRIES REPRODUCER CORP.
World's Foremost Producer of Small Die Castings
159 Beechwood Ave., New Rochelle, N. Y. Phone: NEw Rochelle 3-8600

the user in his shop by adjusting the calibration dial for the desired 100 percent amperage. The doughnut type transformer provides ease of installation by running a motor lead through the transformer window at the switch box, and low voltage is carried to the meter by means of 8 ft leads.

The unit is enclosed in a box of welded 16 gage steel, meeting all standards. The cover is easily removed for calibration purposes by loosening one screw. The meter has been moisture-proofed and the box can be sealed to prevent tampering. Detroit Milling Cutter Co., 28625 Grand River, Farmington, Mich.

For more information—Circle 123, inside back cover

Powdered Metal Spherical Washers

Spherical washers made of powdered metal are being offered in a wide range of sizes. Higher tensile strength, absolute uniformity and the elimination of brittleness are said to result from the use of powdered metal. In addition, this metal retains lubricant exceptionally well. Lodding, Inc., 79 Beacon St., Worcester 1, Mass.

For more information—Circle 124, inside back cover

Electrical Indicating Instruments

A series of electrical indicating instruments that conform to ASA and federal JAN-1-6 specifications includes d-c microammeters, milliammeters, voltmeters and ammeters in a variety of ranges, resistance values and sensitivity. They are available in 2½ and 3½ in. round or square cases, plus 4 in. rectangular models. Modifications can be made to fit individual requirements. These instruments feature the popular external pivot D'Arsonval movements. DeJUR-AMSCO Corp., 45-01 Northern Blvd., Long Island City 1, N. Y.

For more information—Circle 125, inside back cover

Cast Iron Alloy for Severe Abrasion

A hard, abrasion-resistant iron alloy is said to have been heat treated to 700 Bhn. Typical applications are reported to include blades for the pro-

pulsion of blasting grit and steel shot in airless centrifugal blast cleaning equipment, tube elbows in pneumatic metal chip handling systems in automotive plants, brick-making equipment (especially augers and related parts which work the highly abrasive shale and silica particles), mixer paddles in asphalt mixing plants, production equipment in plants processing roofing material, wallboard, and carton stock from crude scrap containing tramp iron, sand and other abrasive matter.

A life expectancy of 2 to 6 times that of other alloys used for the same purposes is indicated. Taylor-Wharton Iron and Steel Co., High Bridge, N. J.

For more information—
Circle 126, inside back cover

Low Amperage Motor Protector

A permanent protective device to fit branch circuits of 4, 4½, 5, 5½, 6, and 7½ amp ratings is intended to protect equipment rather than wiring. This unusual device can be used in a cutout base wired to any motor, appliances or electrical equipment to interrupt excess overloads and short circuits. It trips instantly on "shorts" but has a built-in time lag to handle temporary starting loads and line surges. Service can be restored within 10 sec after an interruption by merely pressing in the shock-proof reset button. It is 100 percent trip-free and will not maintain a circuit that has not been cleared of the overload-causing condition.

According to the manufacturer, the new motor protector is enclosed in a special tamper-proof insulating case. Mechanical Products, Inc., 1800 River St., Jackson, Mich.

For more information—
Circle 127, inside back cover

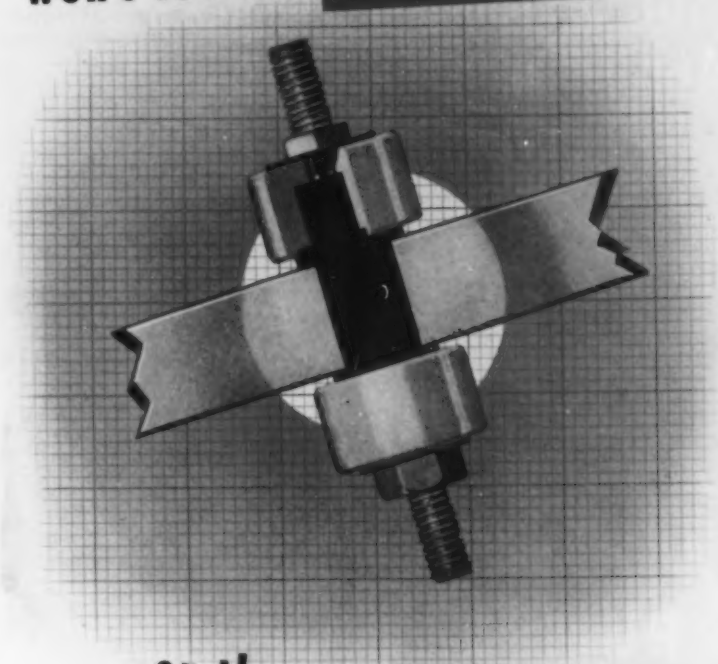
Sub-Miniature Wire-Wound Resistors

These resistors are reported to have an improved method of terminating the winding to the wire leads, minimizing one of the serious weak points present in most sub-miniature components of this type.

Type A is ¼ in. dia. by ¼ in. long. Maximum resistance is 125,000 ohms, and military power rating 0.1 w. Type JC is ¼ in. dia. by ⅜ in. long. Maximum resistance is 250,000 ohms, and power rating 0.15 w. Tolerance of 1 percent is standard and tolerances to

LUNDEY hermetic terminals

won't let the INSIDE OUT!



or the OUTSIDE IN!

Do you have an electrical problem where low-cost *reliable* hermetic sealing is a must, to . . .

- contain highly diffusive gases or liquids, including the freons . . .
- maintain desired pressures . . .
- retain electrical efficiency under adverse environmental conditions?

The Lundey line of hermetic terminals is the answer to the design engineers' increasing demand for *reliable* terminals for hermetic sealing.

With over ten years of successful performance for highly critical military as well as industrial applications, Lundey designs have met unusual specifications, including such requirements as . . .

- excellent resistance to thermal and mechanical shock.
- high current and voltage.
- wide ranges of temperature and pressure.
- ease and simplicity of installation.

Why not let Lundey Associates help you solve *your* next hermetic sealing problem?

Lundey terminal 4780-25W. Designed for heavy-wall sealed motor compressor units. Current capacity 100 amperes, continuous. Voltage rating, 5000 volts, test.

LUNDEY ASSOCIATES

694 MAIN STREET
WALTHAM 54
MASSACHUSETTS

Standard Pumps for Custom Applications

Pioneer PUMPS
IMPELLER TYPES
from 0 to 174 gpm
850 to 3450 rpm

Types available:

Seal and Seal-less
Integral Motor Mounted
Belt and Motor Base
External or Submerged
JIC Standard
Self-Priming Auxiliary Units

Ask for Complete Catalog of Pumps and Accessories

DETROIT HARVESTER Company
PIONEER PUMP Division
14300 Tireman · Detroit 28, Mich.
(FACTORY— Paris, Kentucky)

0.05 percent available. Type J resistors have a mounting hole for a No. 2 machine screw. Leads are of heavily tinned copper wire. Resistance Products Co., 714 Race St., Harrisburg, Pa.

For more information—
Circle 128, inside back cover

Subminiature Toggle Switches

These three-position, panel-mounting, subminiature toggle switch assemblies have two single-pole, double-throw basic switching units, providing control of as many as four circuits and making possible three different combinations of two circuits open and two circuits closed at any time.

The electrical rating of the switches used in each assembly is: 125, 250 v, a-c, 5 amp; 30 v, d-c, 3 amp inductive at sea level, 2.5 amp inductive at 50,000 ft, 4 amp resistive at sea level and 4 amp resistive at 50,000 ft. Micro Switch, Freeport, Ill.

For more information—
Circle 129, inside back cover

Small-Diameter Metal Bellows

Quantity production of $\frac{1}{4}$ and $\frac{5}{16}$-in. dia hydraulically formed seamless bellows in brass, phosphor bronze, beryllium copper and Monel is under way. Typical models are $\frac{1}{4}$ in. dia two-ply, phosphor bronze bellows, $\frac{5}{16}$ in. dia Monel bellows having a wall thickness of 0.002 in. and $\frac{1}{4}$ in. beryllium copper bellows which will withstand maximum external pressure up to 2300 psi. The majority of applications for bellows of these sizes are as components where size is important. Robertshaw-Fulton Controls Co., Bridgeport, Conn.

For more information—
Circle 130, inside back cover

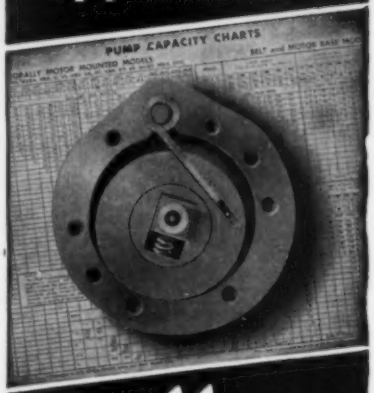
Linear Motion Controller

A new electrical device permits the operator of a linear-motion machine to return the machine to a previous position within 1 percent accuracy.

One feature of the transmitter in this new unit is that the rod which is tied to the machine has no mechanical stop, eliminating mechanical breakage from over-travel. The unit will transmit total travel in ranges from $\frac{1}{8}$ to 3 in. Control Products, Inc., Noblestown Road, Oakdale, Pa.

For more information—
Circle 131, inside back cover

Standard Pumps for Custom Applications



Rollway PUMPS
POSITIVE DISPLACEMENT TYPES
from ⅛ to 60 gpm
200 to 500 rpm

Types available:

Reversing
Non-Reversing
Built with or without Automatic Relief Valve
Single or Double Eccentric
V-Belt or Direct Connected

Ask for Complete Catalog of Pumps and Accessories

DETROIT HARVESTER Company
PIONEER PUMP Division
14300 Tireman · Detroit 28, Mich.
(FACTORY— Paris, Kentucky)

Catalogs and Bulletins

Request additional information using postcards inside back cover

IMPACT SOCKETS, EXTENSIONS, ADAPTERS—Brochure 29-A, 6 pp. Specifications and drawings are included for impact sockets with 1 in. female square drive, for use on hex nuts measuring up to 5¾ in. across flats; similar information is provided for 1½ in. and 2½ in. female square drive sockets, for use on hex nuts measuring up to 10⅝ in. Apex Machine & Tool Co., 1039 S. Patterson Blvd., Dayton 2, Ohio.

Circle 132, inside back cover

BRAIDED PACKINGS—Booklet, 8 pp. Details of construction, recommendations for use, available sizes of flax, cotton and Teflon packings are given. Garlock Packing Co., Palmyra, N. Y.

Circle 133, inside back cover

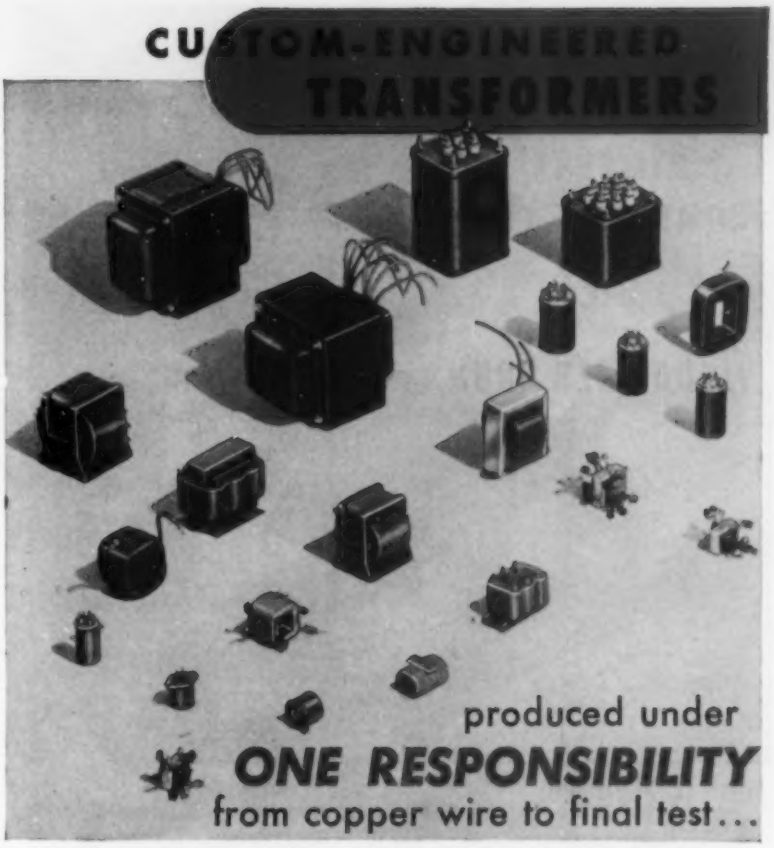
CHAIN DRIVES—Catalog C72-51, 16 pp. Operating principles and test data are included for drives that will carry up to 190 hp per inch of chain width at continuous chain speeds up to 6,000 fpm. Specifications and capacity curves are included for standard ¾, 1, 1¼, 1½ and 2-in. pitch chain from 2 to 12-in. wide. Installation and lubrication recommendations are also included. Morse Chain Co., 7601 Central Ave., Detroit 10, Mich.

Circle 134, inside back cover

FLEXIBLE JOINTS FOR PIPE LINES—Catalog F-8, 12 pp, has detailed specifications on 35 styles of bronze and steel, plain and flanged swing joints. Recommendations and information on use, care and maintenance of equipment. OPW Corp., 2735 Colerain Ave., Cincinnati 25, Ohio.

Circle 135, inside back cover

SOLENOID VALVES—Bulletin A-3, 1 pp, describes and illustrates new



- Wheeler transformers are custom-engineered to meet your specific requirements. Your needs come first with us.
- Wheeler makes its own magnet wire . . . from the copper rod to the finished, insulated and tested product . . . with quality under our control every step of the way.
- Wheeler uses the most modern winding techniques and equipment.
- Wheeler's facilities for the production of intricate coils and assemblies are unexcelled.
- Wheeler affords fullest protection to its transformers with latest techniques in wax and varnish impregnation and FOSTERITE® encapsulation.
- Wheeler transformers are subject to specially devised engineering and test procedures throughout manufacture, and must individually undergo a final comprehensive test before shipment.

To learn what these advantages can mean to you, write:

THE WHEELER INSULATED WIRE COMPANY, INC.
Division of The Sperry Corp.
1103 East Aurora St., Waterbury 20, Conn.

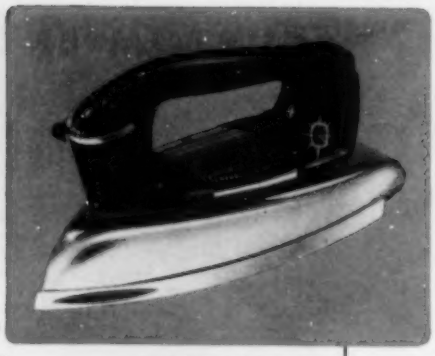
®The WESTINGHOUSE encapsulating material that gives a high degree of protection to small transformers. Applied by Wheeler under license.

WHEELER
MAGNET WIRE COILS
COMMUNICATIONS EQUIPMENT
TRANSFORMERS

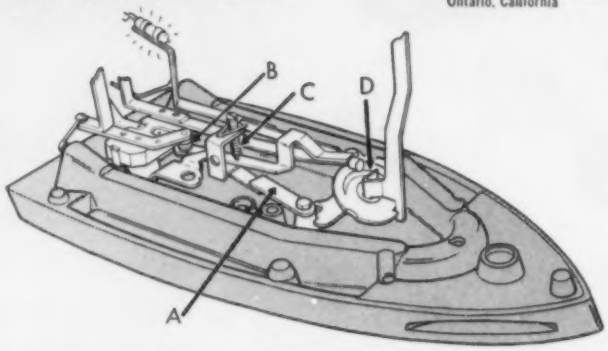
WHEELER *MAKES THESE PRODUCTS A Specialty*

2WH84

HOW CHACE THERMOSTATIC BIMETAL CONTROLS THE G-E VISUALIZER IRON



Product of General Electric Small Appliance Division Ontario, California



CHACE Thermostatic Bimetal meets the exacting specifications for the new General Electric Automatic Visualizer Iron Model F-33. Features of this beautiful design are its Visualizer Fabric-Dial, automatic signal light, light weight of less than 2½ pounds and extra-large soleplate.

The controlling element (A) is composed of two types of thermostatic bimetal welded together. The heavier gauge and the slower of the two to respond is mounted on the soleplate and bends downward as the temperature of the soleplate increases, breaking the circuit at the contacts (B). The lighter and more responsive section of the element carries the mounting bracket for the insulated adjusting screw (C). The faster action of this section causes a more rapid make and break and a steady control of heat for various fabrics. When the points are closed, the safety light flashes on for a few seconds while the current brings the plate up to the correct temperature. Turning the Visualizer cam (D) raises and lowers the ceramic-tipped contact arm; the narrower the gap, the longer the current flows through the plate.

Chace furnishes thermostatic bimetal in 29 types, in strip, random length coils or in complete elements fabricated and assembled to your specifications. Before development of your new controlling, indicating or protecting device, read our booklet, "Successful Applications of Chace Thermostatic Bimetal," containing valuable engineering data. Write for it today.

W. M. CHACE CO.
Thermostatic Bimetal
1407 BEARD AVE., DETROIT 9, MICH.

models. These are normally closed or normally open types in three sizes, 1, 1¼ and 1½ in.—designed to eliminate hammer and shock in automatic or remote control of steam, air, gas or liquid flow. J. D. Gould Co., 730 E. Washington St., Indianapolis 2, Ind.

Circle 136, inside back cover

COPPER-CLAD LAMINATES FOR PRINTED CIRCUITS—Bulletin, 4 pp. Information is given on two electrical grades of high quality, paper-base phenolic laminates, which are bonded to copper foil of 0.0014 and 0.0028 in. thicknesses. Included are design considerations and characteristic properties, punching information and sheet size. Richardson Co., 2661 Lake St., Melrose Park, Ill.

Circle 137, inside back cover

WEAR-RESISTANT STEEL ALLOY—Leaflet, 8 pp, has properties, composition, applications, case histories and information on heat treatment of "Jalloy, Grade 3". Jones & Laughlin Steel Corp., 3 Gateway Center, Pittsburgh 30, Pa.

Circle 138, inside back cover

RESISTORS—Chart gives data for each type, including equivalents, rated wattage, standard tolerances, temperature rise at rated load, temperature coefficient, maximum operating temperature, ohmic values available, dimensions and approximate prices. International Resistance Co., 401 North Broad St., Philadelphia 8, Pa.

Circle 139, inside back cover

LEAD-BEARING STEEL—Memorandum, 3 pp, describes "Ledloy-A", the free machining, lead-bearing steel which machines at speeds much faster than those used for common screw stocks. Included are analysis comparisons, typical mechanical properties and machining comparisons. Peter A. Frasse and Co., Inc., 17 Grand St., New York 13, N. Y.

Circle 140, inside back cover

HARDENABILITY OF STEELS—Bulletin A-63, 12 pp, documented with charts and photo-micrographs. The selection of steels solely on the basis of the usual hardenability tests may be an inadequate procedure especially where optimum performance qualities are essential or desired. Steels with the same end-quench hardness curves or harden-

ability are shown to have much different toughness as measured by notch bar tests at equal hardness and strength levels. International Nickel, New York 5, N. Y.

Circle 141, inside back cover

INVESTMENT CASTINGS—Booklet, 12 pp. Considerations in designing for investment cast parts and a discussion of comparative costs are included, together with a description of the process. Hitchiner Mfg. Co., Inc., Milford, N. H.

Circle 142, inside back cover

WELDLESS CHAIN—Bulletin D, 8 pp, details the various types of link construction used in the making of weldless chain and covers link materials, standard finishes, standard packing and other useful data, including applications of the ten basic types of weldless chain. McKay Co., 329 McKay Building, Pittsburgh 22, Pa.

Circle 143, inside back cover

ELECTRICAL INDICATING INSTRUMENTS—Brochure 4 pp, describes standard range electrical indicating instruments in round, square and rectangular models, adaptable to most panel uses. DeJur-Amsco Corp., 45-01 Northern Blvd., Long Island City 1, N. Y.

Circle 144, inside back cover

METAL POWDERS—Bulletin 1, 4 pp, provides a brief introduction to powder metallurgy. In addition the bulletin describes the general types of metal powder offered by this supplier and some of their uses. Plastic Metals Div., Johnstown, Pa.

Circle 145, inside back cover

RESISTANCE STRIPS AND CONCENTRIC DISC RESISTORS—Bulletin T-1, 4 pp. Data is provided on construction, tolerances, resistance values, power and voltage ratings, dimensions, machining technique, temperature coefficient and voltage coefficient. International Resistance Co., 401 N. Broad St., Philadelphia 8, Pa.

Circle 146, inside back cover

REFRIGERATION CONDENSING UNITS AND COMPRESSORS—Catalog B-54, 6 pp, contains illustrations and specifications on standard air-cooled and water-cooled models, combination air and water-cooled units,

GLOBE PLANETARY GEAR REDUCED MOTORS

MORE OUTPUT TORQUE
than any unit of comparable size

D.C. MOTOR and GEAR REDUCER
Produces output torques up to 2,000 ounce-inches at high gear ratio and low output shaft speeds. Length 3¾ to 3⁹⁄₁₆ inches. Diameter 1¼ inches. Weight, 7¼ to 12 ounces. Voltages from 6 to 100V D.C.

SHOWN ACTUAL SIZE

Globe A.C. or D.C. Planetary Gear Reduced Motors are designed for smooth performance and maximum output torque where minimum space requirements exist. They consist of a miniature Moto-Mite* motor, and a planetary gear reducer having a unique system of precision machined gears. Assemblies are mechanically interlocked, and shaft and last carrier is one integral piece for maximum reliability. Units can be furnished with standard or custom-made mounting flanges and shafts, and are available with speed governors, electromagnetic clutches, brakes, and separate or integral radio noise filters. They are designed to meet all military specifications.

Let Globe's engineers, backed by years of experience in developing custom-built miniature motors and motor products, help design and develop precision motors for your specific requirements.

Shown half-size

A.C. MOTOR and GEAR REDUCER
Hysteresis-Synchronous type motor. Voltages up to 115V A.C. Can be wound for 400 or 60 C.P.S., and can be furnished for single phase capacitor-run, or two phase operation. Length 3³³⁄₆₄ to 4²⁷⁄₆₄ inches. Diameter 1¼ inches. Weight 9¾ to 14½ ounces.

*Trademark

WRITE FOR COMPLETE INFORMATION TODAY!

Globe industries, inc.

MOTORS • GEAR REDUCERS • GENERATORS • GOVERNORS • SERVOS
BLOWERS • FANS • ACTUATORS • SWITCHES • GYROS • VIBRATORS

1802 STANLEY AVE., DAYTON 4, OHIO

Electrol Check Valves

Prevent Reversal of Flow in { AIR . . . OIL OR WATER APPLICATIONS

Electrol (463FP) Check Valves are ideally suited for heavy-duty service applications—providing positive sealing against return flow in air . . . oil . . . or water control lines, with a minimum of pressure drop. They have a maximum operating pressure of 5,000 P. S. I., with a cracking pressure — in free flow direction —from 2 to 8 P. S. I. Elements are of brass and bronze — and include an O-ring check seat. Sizes range from ⅛" to 2" N.P.T. Your inquiries will receive prompt attention.

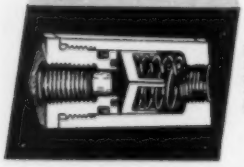


Diagram showing internal construction of the Electrol (463FP) Check Valve.

Better Designed Products Use Electrol Hydraulics

Electrol HYDRAULICS
KINGSTON, NEW YORK
Telephone, Kingston 1980

CYLINDERS • SELECTOR VALVES • FOLLOW-UP VALVES
CHECK VALVES • RELIEF VALVES • HAND PUMPS
POWERPAKS • LANDING GEAR OLEOS • SOLENOID
VALVES • ON-OFF VALVES • SERVO CYLINDERS • TRANSFER
VALVES • CUT-OUT VALVES • SPEED CONTROL VALVES

Catalogs and Bulletins . . . . . continued

gasoline engine-driven types and truck-type models. A chart shows capacity data on various models. Copeland Refrigeration Corp., Sidney, Ohio.
Circle 147, inside back cover

GEARED MOTORS—Folder, 4 pp, describes small fhp geared motors used in products such as photographic equipment laboratory apparatus, instruments, controls, bending machines, animated displays, barbecue drives. Drawings and descriptions are included of available motor windings and control accessories. Merkle-Korff Gear Co., 213 N. Morgan St., Chicago 7, Ill.
Circle 148, inside back cover

VARIABLE SPEED REDUCERS—Leaflet, 2 pp, has tables giving ranges of speed reductions for two models designed for use with ¼ to 2 hp motors. V. S. Expansion Bolt Co., York, Pa.
Circle 149, inside back cover

PRECISION SERVO COMPUTER POTENTIOMETERS—Technical Paper 341, 12 pp, discusses linearity and sets forth data on research, development and trends in precision potentiometers. Originally presented at the AIEE. Conference on Feedback Control Systems. Helipot Corp., South Pasadena, Calif.
Circle 150, inside back cover

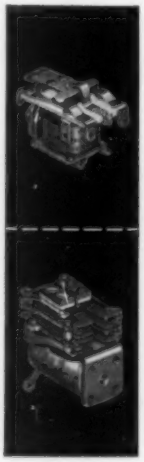
TRANSFORMERS—Catalog, 22 pp, provides electrical and physical specifications on over 500 models. Output charts, cross-reference charts and other helpful data are also included. Chicago Standard Transformer Corp., Addison and Elston, Chicago 18, Ill.
Circle 151, inside back cover

COLLOIDAL DISPERSIONS—Bulletin 460, 8 pp. Centerfold table lists 40 basic dispersions of graphite, molybdenum disulfide, vermiculite and zinc oxide in carriers such as water, oil, volatile hydrocarbons, resin solutions, alcohol, glycol and wax emulsions. Comparative particle size and consistency of each dispersion are given, as well as dilution information and typical applications. Acheson Colloids Co., Port Huron, Mich.
Circle 152, inside back cover

ELECTRIC HEATING EQUIPMENT—Booklet, 30 pp, entitled "101 Ways to Apply Electric Heat". Methods of applying heating equipment to baths, transfer systems, steam generation,

ADVANCE *builds 'em for heavy loads and long service!*

Cramped quarters don't cramp the style of ADVANCE midgets and miniatures. You can use them on loads up to 5 amperes continuously . . . and at three times their rating intermittently—with complete safety. They'll resist shock and vibration . . . stand up under temperature extremes. You'll find them readily adaptable to any mounting need . . . any type of duty. Here are a few examples:



"TINY MITE"
MM & MP SERIES
This ultra-small d-c relay occupies less than ½ cu. in. mounting space! It's stable under vibration and shock . . . plated to prevent corrosion. Operate time is 5 milliseconds. Contact rating: .5 amp. or 1 amp.

MINIATURE TELEPHONE TYPE
TQ SERIES
Only .94 cu. inches in size, yet this relay carries 5-amp. loads in any combination up to 4 PDT. Mechanically secured throughout, it's extremely efficient. No gassing or bubbling. Withstands 10G vibration. Temperature range: −55° to +125° C.

Hermetic enclosures on these types are impervious to varying climatic conditions . . . are sealed and carefully checked against leakage.

Write for literature on any of the above series, or the complete ADVANCE line.

ADVANCE ELECTRIC AND RELAY CO.
2435-C NORTH NAOMI STREET
BURBANK, CALIFORNIA

Sales Representatives in Principal Cities of U.S. and Canada

melting units, piping, ovens, dies and molds, and space heaters is described and illustrated. Edwin L. Wiegand Co., 7500 Thomas Blvd., Pittsburgh 8, Pa.

Circle 153, inside back cover

ROTARY PUMPS—Folder, 6 pp, describes a line of pumps with capacities of 5 to 1500 gpm and discharge pressures to 100 psi, used to handle foods, chemicals, paints and other liquids. Blackmer Pump Co., Grand Rapids, Mich.

Circle 154, incide back cover

SAFETY AND RELIEF VALVES—Catalog 53, 48 pp, has selection tables, drawings, listings of ratings. Series of tables in back give capacities in saturated steam, air, water. Kunkle Valve Co., 121 S Clinton St., Fort Wayne 2, Ind.

Circle 155, inside back cover

CYCLE-CONTROLLING PRESET COUNTERS—Bulletin 202, 34 pp. Photographs, drawings and descriptions of various models of these stroke, revolution or impulse counters and controllers are provided. Counter and Control Corp., 5225 W. Electric Ave., Milwaukee 14, Wis.

Circle 156, inside back cover

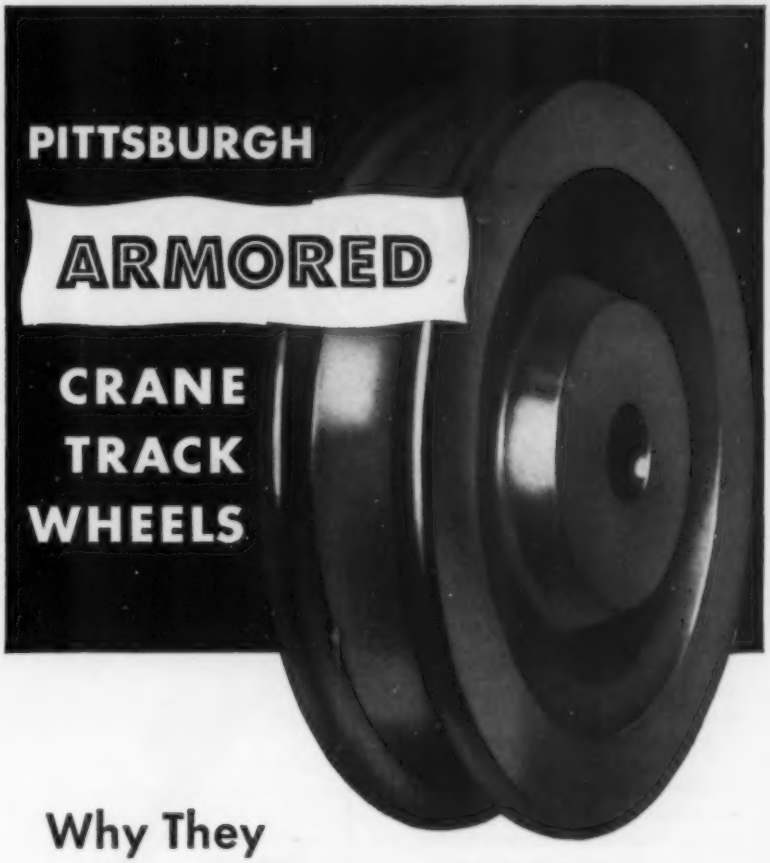
TEMPERATURE CONTROL VALVE—Bulletin 505, 4 pp, has cutaway and schematic drawings of valves and typical applications, together with specification capacities and dimensions. Sterling, Inc., 3738 N. Holton St., Milwaukee 12, Wis.

Circle 157, inside back cover

HOSE COUPLINGS AND FITTINGS—Catalog 54, 103 pp. Contains engineering drawings, cutaways, charts, tables giving construction details, capacities, specifications on hose couplings, adapters, unions, check valves, hose and spring guards. Anchor Coupling Co., Inc., E. Church and Fourth St., Libertyville, Ill.

Circle 158, inside back cover

INTERVAL TIMERS—Data sheet, 2 pp, describes techniques and equipment for measuring time intervals from a fraction of a microsecond to 1 sec (or longer if desired) with accuracies as high as $\pm\frac{1}{2}$ microsecond by electronically counting the exact number of pulses produced by a highly-stable



Why They Give Exceptional Service...

• The secret of the long life of PITTSBURGH **Armored** Crane Wheels lies in something you can't see. It's part of the process perfected by PITTSBURGH which puts the right hardness in the right places. The treads and flanges are armored to the extra hardness of 601-712 B.H.N. 81-95 SC. But the cores? They are left tough and highly resistant to shock.

• This combination of hard treads and tough cores gives average service life up to five times that of untreated gears. It is your assurance of lower crane wheel costs. And PITTSBURGH gives you a written guarantee that you'll get this exceptional service.

• Available in sizes from 10" to 30" diameter. Treads: flat, tapered, radius, or "Pittsburgh Gear Company Standard." Bores and hubs may be finished by you or by us to your specifications.

Do This Today: Send us specifications of the wheels you use and we'll quote on PITTSBURGH Armored Crane Track Wheels ...guaranteed to give longer service.

PITTSBURGH GEAR COMPANY
Neville Island
Pittsburgh 25, Pa.
Phone: SPaulding 1-4600
subsidiary of BRAD FOOTE GEAR WORKS, INC. • CICERO 50, ILLINOIS

...How about Malleable?

Make Your Products Tough–Durable–Safe

The ability of malleable iron to withstand severe impact and shock and its high resistance to atmospheric corrosion make malleable castings extremely valuable for products that must be rugged and durable.

Machining time and cost are often saved because malleable can be cast close to final form and even formed to final dimensions by fast and inexpensive press or coining operations. No ferrous material can be machined with greater ease.

Take advantage of malleable's toughness, ductility and resistance to shock and corrosion when designing new products or when looking for ways to cut costs or improve present production. Call a malleable foundry and have their engineers go over your products with you. They will show you how to utilize malleable's properties to design better products at lower cost.

Famous RIDGID Pipe Wrenches Use Malleable

The Ridge Tool Company makes the handle and housing of their pipe wrenches of tough, rugged malleable to assure dependable and safe performance. Every RIDGID Pipe Wrench carries an unconditional guarantee that the housing will not break or distort or it will be replaced free.

Send for "Malleable Iron Facts" Bulletin No. 46. Data on design, application and physical properties of malleable iron to help you design with malleable. Just write to The Malleable Founders' Society.

Malleable FOUNDERS' SOCIETY

1800 Union Commerce Building **Cleveland 14, Ohio**

crystal-controlled high-frequency oscillator during unknown interval. Potter Instrument Co., Inc., 115 Cutter Mill Road, Great Neck, N. Y.

Circle 159, inside back cover

HIGH-TEMPERATURE STEEL TUBING—Data card, 1 pp, presents stress rupture data on eleven tubing steels, including carbon steel, intermediate chrome-molybdenum steels and stainless steels. Babcock & Wilcox Co., Beaver Falls, Pa.

Circle 160, inside back cover

PRESSURE LUBRICATION FILTERS—Bulletin, 2 pp, includes dimensional material, illustrations, diagrams, and comprehensive data charts. Trabon Engineering Corp., 1814 E. 40 St., Cleveland, Ohio.

Circle 161, inside back cover

NICKEL ALLOY STEELS—Bulletin A-68, 36 pp. Over 70 mechanical property charts show the properties which may be regularly expected in various section sizes. International Nickel Co., Inc., New York 5, N. Y.

Circle 162, inside back cover

IN-LINE VALVES—Bulletin, 8 pp. has photographs, engineering drawings, capacities, dimensions, parts lists of two-way and three-way solenoid and pilot operated valves. Numatics Operating Valve, Milford, Mich.

Circle 163, inside back cover

SOLDERS—Booklet, 80 pp, discusses nature of solders, fluxes, flux-core solders, design and application considerations. Kester Solder Co., 4201 Wrightwood Ave, Chicago 39, Ill.

Circle 164, inside back cover

BERYLLIUM COPPER STRIP—Bulletin 2, 4 pp, presents information on mill-hardened strip that requires no heat treatment. Describes material supplied with thickness and flatness tolerances not previously available. Includes discussion of temper selection together with tables covering sizes and properties. Penn Precision Products, Inc., 501 Crescent Ave., Reading, Pa.

Circle 165, inside back cover

FHP VARIABLE SPEED MOTOR DRIVE—Catalog M-543, 22 pp, contains descriptions and listings of operating features and controls, installations, instructions on how to select the

proper unit, prices and ratings, dimensions and assemblies, standard modifications and accessories. Reeves Pulley Co., Columbus, Ind.

Circle 166, inside back cover

EPOXY RESINS—Bulletins 1, 2 and 3, 6 pp each. Describes resins which, with the proper hardeners, can be used in tooling, casting, laminating, potting, encapsulating, embedding and adhesive applications. Specific data are given on the physical properties of individual resins and hardeners, together with the physical, chemical and electrical properties of recommended resin-hardener combinations. Bakelite Co., 300 Madisin Ave., New York 17, N. Y.

Circle 167, inside back cover

DOUBLE-HEX NUT—Brochure, 12 pp, describes new 12-pointer nut. Sizes, styles, weights, engineering data and prices are included. National Machine Products Co., 44225 Utica Road, Utica, Mich.

Circle 168, inside back cover

PHENOLIC RESINS — Conversion slide rule shows the amounts of resin and accelerator required to produce a cast phenolic part of any size. Alongside a listing of phenolic casting resins, a table shows the percentage by weight of the appropriate hardener to be used with each. Moving a slide gage to any of the resin numbers listed provides information on such physical properties as hardness, impact strength, compressive strength. The cubic area of the part or product to be made is determined by lining up markings for the part's height, width and length. Slides on the front of the chart provide the poundage of resin needed per cubic inch or cubic foot. Marblette Corp., 37-21 Thirtieth St., Long Island City 1, N. Y.

Circle 169, inside back cover

BELT DRIVES—Bulletin 2098, 4 pp, describes a type of belt drive in which, in effect, multiple "V"-belts have been molded as a single unit in a wide belt with "V"-shaped grooves. Browning Mfg. Co., Maysville, Ky.

Circle 170, inside back cover

PLUG VALVE ACTUATORS—Bulletin 3020, 8 pp, describes tandem-type actuators for valves requiring relatively high torques to operate and the new floating bar type actuators for use on valves requiring lower operating

need a finish
that blocks corrosion by itself—or under paint? specify IRIDITE

You can solve any problem of non-ferrous finishing . . . maximum corrosion protection . . . sparkling clear or colored decorative finishes, firm and lasting base for paint . . . with these two words—"specify Iridite". For example—

- **ON ZINC AND CADMIUM** you can get highly corrosion resistant finishes to meet any military or civilian specifications and ranging in appearance from olive drab through sparkling bright and dyed colors.
- **ON COPPER . . .** Iridite brightens copper, keeps it tarnish-free; also lets you drastically cut the cost of copper-chrome plating by reducing the need for buffing.
- **ON ALUMINUM** Iridite gives you a choice of natural aluminum, a golden yellow or dye colored finishes. No special racks. No high temperatures. No long immersion. Process in bulk.
- **ON MAGNESIUM** Iridite provides a highly protective film in deepening shades of brown. No boiling, elaborate cleaning or long immersions.

AND IRIDITE IS EASY TO APPLY. Goes on at room temperature by dip, brush or spray. No electrolysis. No special equipment. No exhausts. No specially trained operators. Single dip for basic coatings. Double dip for dye colors. The protective Iridite coating is not a superimposed film, cannot flake, chip or peel.

WANT TO KNOW MORE? We'll gladly treat samples or send you complete data. Write direct or call in your Iridite Field Engineer. He's listed under "Plating Supplies" in your classified telephone book.

ALLIED RESEARCH PRODUCTS, INCORPORATED
4004-06 E. MONUMENT STREET • BALTIMORE 5, MD

Pump manufacturer *standardizes* on LATTICE BRAID* Packing for *all* centrifugal pump models

*Registered Trademark. *Only* Garlock makes LATTICE BRAID rod and shaft packings.

Peerless Pump Division, Food Machinery and Chemical Corporation, Los Angeles, manufactures an entire line of centrifugal pumps. Before changing to LATTICE BRAID, Peerless regularly received frequent complaints on packing from their customers. Now that Peerless has *standardized* on LATTICE BRAID, complaints are rare. In addition, Peerless reports that LATTICE BRAID *resists* the excessive gland pressure often applied by uninformed repairmen. The result is that there is *less* packing and sleeve wear.

Put Garlock LATTICE BRAID Packing to work for your company. All the braided strands of this unique packing are lattice linked together into one structural unit. The strands hold together even when the packing is worn far beyond the limits of wear of ordinary braided packings.

LATTICE BRAID is made from flax, cotton, asbestos, wire-inserted asbestos, Teflon, and asbestos with Teflon impregnation—for various types of services.

Get all the facts about LATTICE BRAID *Packings. Contact your Garlock representative or write for new folder AD-131.*

THE GARLOCK PACKING COMPANY, PALMYRA, NEW YORK

Sales Offices and Warehouses: Baltimore • Birmingham • Boston • Buffalo • Chicago • Cincinnati • Cleveland Denver • Detroit • Houston • Los Angeles • New Orleans • New York City • Palmyra (N.Y.) • Philadelphia Pittsburgh • Portland (Oregon) • Salt Lake City • San Francisco • St. Louis • Seattle • Spokane • Tulsa.

In Canada: The Garlock Packing Company of Canada Ltd., Toronto, Ont.

GARLOCK LATTICE BRAID PACKING

Catalogs and Bulletins.....continued

torques. Actuator selection table, typical applications, dimensions and weights and various mountings are also included. Ledeen Manufacturing Co., 1600 S. San Pedro St., Los Angeles 15, Calif.

Circle 171, inside back cover

SEMI-PNEUMATIC AND SOLID TIRES AND WHEELS—Catalog 53, 3 pp. Dimensions, axle bore sizes, capacities, weights of wheels, tires, caster assemblies are given. Goddeyne Wheel Products, Bay City, Mich.

Circle 172, inside back cover

SAFETY VALVE—Bulletin 306, 9 pp, describes valve-and-solenoid assembly designed to safeguard clutch and brake operation in heavy machinery such as presses. Cutaway, schematic drawings in color illustrate operation and curves describe valve response time and pressure drop. Ross Operating Valve Co., 120 E. Golden Gate, Detroit 3, Mich.

Circle 173, inside back cover

TITANIUM ALLOY—Booklet, 4 pp, gives complete physical properties, forging recommendations for MST 3A1-5Cr alloy. This is an alloy containing 3 percent aluminum, 5 percent chromium and less than 0.1 percent carbon, and was developed primarily for bar and forging applications. Mallory-Sharon Titanium Corp., Niles, Ohio.

Circle 174, inside back cover

MOLYBDENUM DISULFIDE — Technical paper reprint, 4 pp, "Lubrication Properties and Industrial Applications of Pure Molybdenum Disulfide" was given before the American Society of Lubrication Engineers. How the thin oxide films that form on most metals almost immediately after cutting or shearing act as lubricants and reduce friction by substantial amounts and how they can be improved by alloying or supplementing with more highly qualified solid lubricants is discussed. Alpha Corp., Greenwich, Conn.

Circle 175, inside back cover

ALLOYS FOR ANCHORING NON-MOVING PARTS—Bulletin, 4 pp, tells how expanding, low-melting-point alloys such as bismuth-lead-tin can be used to anchor such parts as bearings, bushings and other non-moving components in machinery, jigs, workhold-

ers. Several applications are described and illustrated. Cerro de Pasco Corp., 40 Wall St., New York 5, N. Y.

Circle 176, inside back cover

CONTROL VALVES—Bulletin 307, 4 pp, describes a four-way, 2-in. high valve with poppet-type seals. Contains operation and recommended service information, installation data, parts list and "exploded" view of component parts. Ross Operating Valve Co., 120 E. Golden Gate Ave., Detroit 3, Mich.

Circle 177, inside back cover

STEEL VALVES—Bulletin 542, 4 pp, contains data on valve material, installation and usage. Edward Valves, Inc., 1201 W. 145 St., East Chicago, Inc.

Circle 178, inside back cover

CAPACITORS—Catalog 800B, 31 pp. Capacities, dimensions, working voltages, prices of several lines of capacitors are given. Sangamo Electric Co., Marion, Ill.

Circle 179, inside back cover

FLOW REGULATORS—Bulletin, 2 pp, provides capacities, dimensions and engineering drawings and exploded views of a series of flow regulators. Waterman Engineering Co., 725 Custer Ave., Evanston, Ill.

Circle 180, inside back cover

MOTORIZED REDUCERS—Bulletin 3100, 26 pp, has selection tables, dimensions, weights, overhung load ratings and thrust capacity ratings needed to select horizontal, vertical or right angle reducers. A foldout section contains information on mounting positions, low speed shaft connections. Falk Corp., 3001 W. Canal St., Milwaukee 8, Wis.

Circle 181, inside back cover

VARIABLE SPEED LIQUID DRIVES—Bulletin 7020-A, 8 pp. Details of construction, dimensions, ratings and capacities are all given. Liquid Drive Corp., Holly, Mich.

Circle 182, inside back cover

PNEUMATIC CONTROLLER—Catalog 53-10, 12 pp. Stack-type pneumatic controllers for process variables are illustrated with cut-away construction photos, schematic diagrams and dimension drawings. Specifications, controller response actions and a controller selection guide give details of case-mounted, field-mounted, and valve-

Model A 23 Calivolter

CALIDYNE'S NEW CALIVOLTER*

WHAT THE CALIVOLTER IS

The Calivolter is a precise electrical instrument which provides an accurate voltage output over a wide frequency range. True r.m.s. voltages regardless of waveform, and accuracy of ±½% are outstanding features. The Calivolter fills a long recognized need for an extremely accurate but inexpensive voltage standard.

***Trademark**

WHAT THE CALIVOLTER DOES

The Calivolter may be used to measure accurately the e.m.f. of voltage-producing vibration, pressure, and seismic pick-ups, as well as strain-measuring devices. It provides a means for accurately calibrating voltage detectors and voltage-sensitive devices such as Vacuum Tube Voltmeters, Oscilloscopes and Sensitive Relays. It may also be used for over-all calibrations of Recording Systems, and for measuring the frequency-response of Amplifiers, Recording Systems, Transformers, High Impedance Meters, etc.

WHAT THE CALIVOLTER OFFERS

Here are some of the advantages and features which you get with the Calivolter:

- *Accuracy ±½% from DC to 10KC — useful to at least 20KC.*
- *Voltage output from 10 microvolts to 10 volts in 5 continuous ranges.*
- *Easy operation, simple standardization.*
- *Low output impedance — max. 1000 ohms.*
- *No current waveform error.*
- *Current output — 1 microamp to 10 ma in decade steps.*
- *A transfer switch and input connection for "unknown" facilitates measurements by substitution.*
- *Small size (8" x 8½" x 4" o.a.)*
- *Lightweight (6¼ lbs.), sturdy construction, matchless quality.*

Write today for specifications and price.

THE CALIDYNE COMPANY

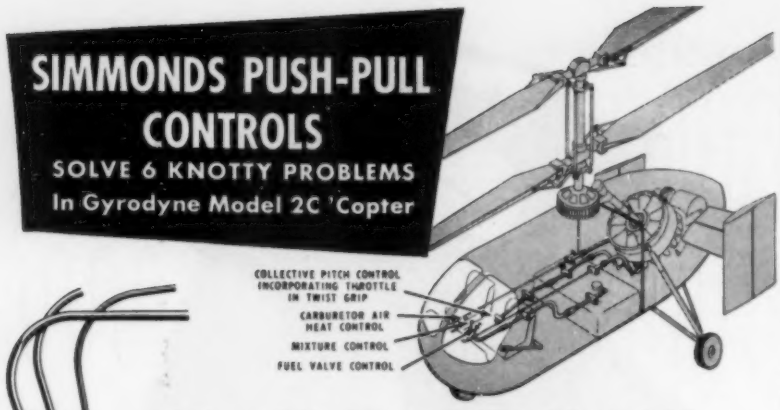
120 CROSS STREET, WINCHESTER, MASSACHUSETTS

SALES REPRESENTATIVES:

NEW YORK CITY AREA
G. C. Engel, Rector 2-0091
EXPORT
Rocke International Corp.
13 East 40th St. N. Y. 16, N. Y.
Murray Hill 9-0200
NORTHERN NEW YORK
Technical Services Co., Boston
Capitol 7-9797
NEW JERSEY
G. C. Engel, Ridgewood 6-7878
PHILADELPHIA, PA.
G. C. Engel, Chestnut Hill 8-0892
CLEVELAND, OHIO
M. P. Odell Co., Prospect 1-6171
DAYTON, OHIO
M. P. Odell Co., Oregon 4441
WASHINGTON, D. C.
F. B. Jodon, Inc., Woodley 6-2615
CHICAGO, ILLINOIS
Hugh Marsland Co.
Ambassador 2-1555
DALLAS, TEXAS
John A. Green Co., Dixon 9918
WALTHAM, MASS.
Robert A. Waters, Inc.
Waltham 5-6900
HOLLYWOOD, CALIFORNIA
G. B. Miller Co., Hollywood 9-6305
SEATTLE, WASH.
G. B. Miller Co., Lander -3320
ALBUQUERQUE, NEW MEXICO
G. B. Miller Co.
Albuquerque 5-8606
SAN FRANCISCO, CALIF.
G. B. Miller, Lytell 3-3438
MINNEAPOLIS, MINN.
H. M. Richardson and Co.
Geneva 4078
NEW HAVEN, CONN.
Robert A. Waters, Inc.
Fulton 7-6760
CANADA
Measurement Engineering Limited
Arnprior, Ont. Phone 400

SIMMONDS PUSH-PULL CONTROLS

SOLVE 6 KNOTTY PROBLEMS
In Gyrodyne Model 2C 'Copter


COLLECTIVE PITCH CONTROL INCORPORATING THROTTLE IN TWIST GRIP
CARBURETOR AIR HEAT CONTROL
MIXTURE CONTROL
FUEL VALVE CONTROL

A RANGE OF SIZES, VARIETY OF FITTINGS

Designers of this advanced coaxial rotor helicopter had these problems in laying out the engine controls of this ship: constant high amplitude, low frequency vibration, confined space aft of the firewall, unusual position of the carburetor beneath engine and a requirement for minimum backlash and easy working controls under little leverage. All these requirements were met by Simmonds Precision Push-Pull Control Systems—one of a long list of successful applications of Simmonds controls on advanced helicopters and other military and commercial aircraft.

Write for detailed information on Simmonds Precision Push-Pull Controls.

Simmonds AEROCESSORIES, INC.
General Offices: TARRYTOWN, N. Y.

Branch Offices: GLENDALE, CALIF. • DALLAS, TEXAS • DAYTON, OHIO
Sole Canadian Licensee: SIMMONDS AEROCESSORIES OF CANADA, LIMITED, MONTREAL

Everyone knows this
is a sign of refreshment...

And smart gear users know
this CINTI is the sign of
the best in custom made gears.

CINTI "Gears...Good Gears Only"

THE CINCINNATI GEAR CO. • CINCINNATI 27, OHIO

mounted control instruments. Fischer & Porter Co., 148 Jacksonville Road, Hatboro, Pa.

Circle 183, inside back cover

CHEMICAL FEEDER—Catalog Sheet 700-50, 2 pp, small, low-cost feeder for metering, controlling, mixing and dispensing small quantities of liquid chemicals is illustrated and specifications, capacities, installation diagrams and applications are provided. Fischer & Porter Co., 149 Jacksonville Road, Hatboro, Pa.

Circle 184, inside back cover

NEEDLE CONTROL VALVES—Bulletin 5C-13, 8 pp, includes a table of nominal needle sizes with corresponding valve coefficients and a characteristic curve showing the percent of maximum flow in relation to the percent of total lift. Formulas and instructions for calculating the size of a suitable control valve for use with liquids, gases and steam are given. Foxboro Co., Foxboro, Mass.

Circle 185, inside back cover

METERS AND CONTROLS—Bulletin 17, 16 pp. Detailed equipment descriptions and illustrations include basic specifications for measuring, transmitting, receiving, interpreting and controlling 18 variables normally encountered in production processes. Bailey Meter Co., 1050 Ivanhoe Road, Cleveland 10, Ohio.

Circle 186, inside back cover

ZIRCONIUM—Booklet, 64 pp, describes history and production of zirconium. The mechanical and physical properties, chemical properties, facts about fabrication of zirconium such as melting, forging, rolling, welding, machinability are discussed. One chapter treats of zirconium chemicals such as zirconium tetrachloride, dioxide, sulphate. The appendix lists data on crystallographic features, atomic and nuclear properties. Carborundum Metals Co., Inc., Akron, N. Y.

Circle 187, inside back cover

TIMING MOTORS—Bulletin, 4 pp, gives speeds, dimensions, voltages and other specifications. Hansen Mfg. Co., Inc., Princeton, Ind.

Circle 188, inside back cover

GRINDING WHEELS—Booklet. Proper operating speeds of all types of grinding wheels are given on large

easy-to-follow tables. Chicago Wheel & Mfg. Co., 1101 W. Monroe St., Chicago 7, Ill.

Circle 189, inside back cover

FLAME-PLATING—Booklet, 15 pp, describes process for depositing thin coatings of tungsten carbide on the surfaces of parts and many tools where extra resistance to wear is required. Advantages and properties are described. Linde Air Products Co., 30 E. 42 St., New York 17, N. Y.

Circle 190, inside back cover

STAINLESS STEEL FASTENINGS SPECIFICATIONS—Chart, 2 pp, gives latest specifications applying to U. S. Military, U. S. Army-Navy Aeronautical, U. S. Navy, U. S. Army and Federal requirements. Star Stainless Screw Co., 195 Union Ave., Paterson 2, N. J.

Circle 191, inside back cover

IRON POWDERS FOR ELECTRONIC CORES—Data sheets PMS-12-A-R2 and B-R2, 2 pp, mimeographed, give composition and characteristics of electronic iron core materials as submitted to the Metal Powder Association. Particle size, apparent density, frequency range, relative permeability and "Q" value, and itemized electronic uses for various iron powders are provided. Plastic Metals Div., Johnstown, Pa.

Circle 192, inside back cover

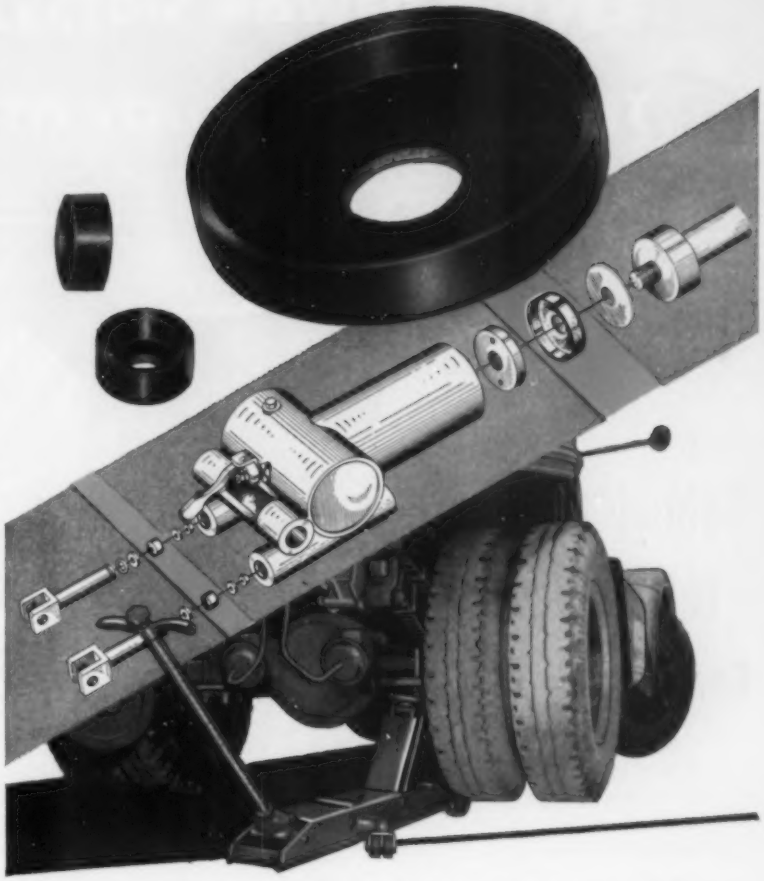
COPPER-CLAD PLASTIC FOR PRINTED CIRCUITS—Booklet, 11 pp. Describes production process, soldering, applications, inks, properties, dimensions and specifications. Formica Co., 4614 Spring Grove Ave., Cincinnati 32, Ohio.

Circle 193, inside back cover

MINIATURE REPEAT CYCLE TIMERS—Bulletin, 2 pp, describes cycling time, timing accuracy, detail characteristics and determination of timing tolerances. A. W. Haydon Co., 230 N. Elm St., Waterbury, Conn.

Circle 194, inside back cover

METERING FLOW TUBE—Bulletin 115-L3, 16 pp, describes a short differential producing metering device which is said to have the lowest permanent loss of head of any known velocity-increasing differential producer. Includes information on: recovery char-



How G&K-INTERNATIONAL helps R V Jack Corporation build hydraulic jacks that stay put under full load

In principle, the hydraulic jack is quite simple. Oil, drawn from a reservoir into the pump chamber, is forced into the main cylinder, causing a piston to move and operate a load-lifting mechanism.

In practice, the piston head packing has a heavy responsibility. Any leakage around the packing could cause the load to settle.

R V Jack Corporation (Arcade, New York) manufactures automobile jacks. In their 4-ton and 10-ton jobs they were using leather cup packings — and getting leakage. G&K-INTERNATIONAL developed a cup packing with *square shoulders* made of specially impregnated leather (grain outside) and held to extremely close tolerances. *There is no more leakage.*

Working in both leather and synthetic rubber, G&K-INTERNATIONAL can help *you* take full advantage of the best qualities in each material — the best features in standard or special packings designs.

Write for G&K-INTERNATIONAL Catalog and Manual 201-A . . . latest JIC and recommended sizes for cups, flanges, U's, V's, O-Rings, with facts on oil seals and specialties.

G&K-INTERNATIONAL *Packings*

GRATON AND KNIGHT LEATHER — SYNTHETIC RUBBER

GRATON & KNIGHT COMPANY, Worcester, Massachusetts
INTERNATIONAL PACKINGS CORPORATION, Bristol, N. H.

Rubber Television Anode Shield Manufactured by Continental for the Ucinite Company

Behind your television screen . . .

Continental Rubber gets into the act

In the unseen act behind your television screen, a small cup-shaped rubber shield plays an important role. This shield fits over the anode on the side of the tube. Its function is to "seal in" high voltage current and thus prevent surface discharges that cause picture distortion.

Ordinary rubber compounds, of course, can't fill the bill. *This* rubber part must have exceptional dielectric properties and unusual stability under sustained heat. It must resist the deteriorating effects of ozone created by electrical discharges. In addition, the rubber shield must be precision molded to insure proper seating against the side of the television tube.

Continental engineers, working closely with Ucinite Company engineers, have met these exacting requirements. This technical cooperation typifies the service in rubber offered by Continental.

When *you* need better engineered rubber parts, why not enlist the service of specialists in molded and extruded rubber?

LET US SEND YOU THIS CATALOG

This new engineering catalog lists hundreds of standard grommets, bushings, rings and extruded shapes. It will be a valuable addition to your working file. Send for your copy today or . . .

See our Catalog in Sweet's File for Product Designers

MANUFACTURERS SINCE 1903

CONTINENTAL RUBBER WORKS

1982 LIBERTY BOULEVARD • ERIE 6, PENNSYLVANIA

BRANCHES

Baltimore, Md.	Cleveland, Ohio	Kansas City, Mo.	Pittsburgh, Pa.
Boston, Mass.	Dayton, Ohio	Los Angeles, Calif.	Rochester, N. Y.
Buffalo, N. Y.	Detroit, Mich.	Memphis, Tenn.	St. Louis, Mo.
Chicago, Ill.	Hartford, Conn.	New York, N. Y.	San Francisco, Calif.
Cincinnati, Ohio	Indianapolis, Ind.	Philadelphia, Pa.	Syracuse, N. Y.

acteristics, accuracy, applications, range, flow formula, laying length and working presure of the device, installation, power consumption, effort of approach and downstream piping and fittings, and location of instruments. Builders-Providence, Inc., 345 Harris Ave., Providence, R. I.

Circle 195, inside back cover

TAMPER-PROOF SEALER — Data sheet, 2 pp. Typical applications, properties, chemical resistance and application of this sealer are described. Minnesota Mining and Manufacturing Co., 423 Piquette Ave., Detroit 2, Mich.

Circle 196, inside back cover

PRECISION COMPONENTS—External house organ, 4 pp. First issue of new publication, entitled "O-pinions". Research Development Manufacture, Inc., 429 E. Collom St., Philadelphia 44, Pa.

Circle 197, inside back cover

ALUMINUM ALLOY DESIGNATIONS—Booklet, 8 pp. Describes new alloy designation system developed by Aluminum Association for wrought aluminum and alloy products, to become effective Oct. 1, 1954. A conversion table listing new and old designations is provided. Aluminum Association, 420 Lexington Ave., New York 17, N. Y.

Circle 198, inside back cover

WIRE THREAD INSERTS—Bulletin 708, 4 pp, twenty illustrations and five tables present data and installations on inserts and tools for National Coarse and Fine, Unified Coarse and Fine, Spark Plug and Pipe Thread series. Inserts are listed in sizes from No. 4 through 1½ in. dia and for 3, 3B, 2 and 2B class of fit. Heli-Coil Corp., Danbury, Conn.

Circle 199, inside back cover

ROLLER CHAIN AND SPROCKETS —Catalog 754, 64 pp. The line illustrated and described includes minimum bore sprockets for reboring as well as finished bore and bushed sprockets which are ready to use. Chain selection and application data is included. Diamond Chain Co., Inc., Indianapolis 7, Ind.

Circle 200, inside back cover

BYPASS AND RESTRICTOR FLOW REGULATORS—Catalog sheets, 6

STERLING ELECTRIC POWER DRIVES

ENGINEERED TO YOUR REQUIREMENTS

For the Best ★★★

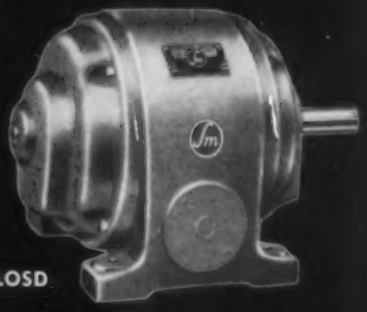
★ VARIABLE SPEED

SPEED-TROL

★ LOW SPEED

SLO-SPEED

★ CONSTANT NORMAL SPEED



KLOSD

20-page illustrated catalog... Sterling Speed-Trol, Slo-Speed, Klosd and Klosd-Tite Electric Power Drives. Write for catalog No. 574.

STERLING ELECTRIC MOTORS

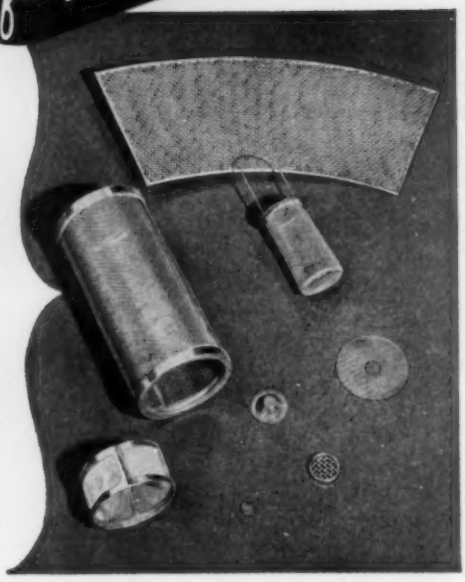
Plants: New York City 51 • Van Wert, Ohio • Los Angeles 22 • Hamilton, Canada • Santiago, Chile

Offices and distributors in all principal cities.

Our Slogan...

NEWARK for ACCURACY

applies also to "fabricated" wire cloth inserts



Our slogan, Newark for Accuracy, has long been known to users of bulk wire mesh cloth, wire space cloth and wire filter cloth. It is now becoming more and more familiar to users of parts fabricated from wire cloth made by a fast-growing division of our company.

These parts, similar to those illustrated, are fabricated or assembled for our customers by skilled workmen in our large department specializing in this work. We are equipped to handle small lots or in production quantities of anything from large jet intake screens to tiny fuel pump strainers.

We shall be glad to quote on your requirements; and, if necessary, our experienced engineers stand ready to assist you in the design of the part so as to make the best use of the mesh and to assure the most economical manufacture of the part as a whole.

Remember, since we weave the cloth used, and do all the necessary cutting, fitting, stamping, punching, forming, binding, welding and soldering, there is only one responsibility . . . OUR responsibility . . . to deliver parts that live up to our slogan — Newark for Accuracy.

We can furnish wire cloth woven from all commercially used metals. Sizes range from 4 inches (space cloth) to 400 mesh.

Newark Wire Cloth COMPANY

351 VERONA AVENUE • NEWARK 4, NEW JERSEY

Catalogs and Bulletins.....continued

pp, detail use and operation of combination bypass and restrictor-type regulators. Engineering drawings show construction. Data on pipe sizes, dimensions and weights are also included. Fluid Controls, Inc., 1284 N. Center St., Mentor, Ohio.

Circle 201, inside back cover

CHECK VALVES—Bulletin WH654, 4 pp, includes a series of dimensional charts for valves of various sizes and pressure ratings. Williams Gauge Co., Inc., 1620 Pennsylvania Ave., Pittsburgh 33, Pa.

Circle 202, inside back cover

SOLENOID VALVES—Bulletin M-500, 4 pp, provides design and performance characteristics of diaphragm-operated solenoid valves; illustrated with photographs, line drawings, specifications and tables. Cross-section views show open and closed positions of the valve's only two moving parts—solenoid plunger and synthetic rubber diaphragm. Eclipse Fuel Engineering Co., 1012 Buchanan St., Rockford, Ill.

Circle 203, inside back cover

HYDRAULIC DRIVE UNITS—Bulletin 56610, 8 pp. Packaged hydraulic drive output units consisting of constant displacement axial piston motors integral with concentric and right-angle all-steel reducers are described. Oilgear Co., 1578-C W. Pierce St., Milwaukee 4, Wis.

Circle 204, inside back cover

CONTROL VALVES—Catalog, 4 pp, describes flow control valves, direct operating pressure controls and pilot-operated check valves. Photographs and charts of all three of the products are included. Denison Engineering Co., 1160 Dublin Road, Columbus, Ohio.

Circle 205, inside back cover

A-C AND D-C GENERATORS—Catalog EI-1A, 24 pp, describes over 170 generators in following categories: d-c permanent magnet tachometer, d-c wound field, d-c speed-squared, d-c dual field, a-c permanent magnet, a-c sine wave. Electric Indicator Co., Inc., Camp Ave., Springdale, Conn.

Circle 206, inside back cover

CENTRIFUGAL PUMPS — Bulletin 247, 4 pp, includes basic design and construction features, sectional and external views; also composite dimen-

sions, material specifications and other technical information. Warren Steam Pump Co., Inc., Warren, Mass.

Circle 207, inside back cover

FLOAT POSITION TRANSMITTERS—Bulletin 170, 4 pp, gives operating details and specifications of new force balance float position transmitter for use with all types pneumatic receivers and /or control instruments. Brooks Rotameter Co., Lansdale, Pa.

Circle 208, inside back cover

LINEAR ACCELEROMETERS—Bulletin AL-1, 4 pp. Accelerometers described are suitable for static and dynamic measurements. The resistive nature of the balanced four-arm bridge permits operation in either d-c or a-c circuits so that a wide range of recording, telemetering, and controlling systems may be employed. Statham Laboratories, Inc., Los Angeles, Calif.

Circle 209, inside back cover

HYDRAULIC PUMP—Bulletin, 4 pp, lists eight models with discharge pressures from 1,100 to 33,500 psi and describes operation of units in high-pressure, low-volume service such as hydrostatic testing, hydraulic presses and other hydraulic machines for clamping, riveting, crimping, shearing and punching. Sprague Engineering & Sales Corp., Gardena, Calif.

Circle 210, inside back cover

VIBRATION AND SHOCK MOUNTINGS—Booklet 850, 4 pp, describes a new concept of vibration and shock control based on the employment of resilient, load-carrying cushions of knitted metal wire. Examples of typical industrial mounts and mounting systems are illustrated and engineering data given. Robinson Aviation, Inc., Teterboro, N. J.

Circle 211, inside back cover

MINIATURE CAPACITORS—Catalog X-100, 20 pp, illustrating and fully describing a complete line of miniature, hermetically sealed, elevated temperature tubular paper capacitors has dimensional drawings, electrical characteristics, engineering data and tables of voltages, capacitance values and tolerances. Gudeman Co., 340 W. Huron St., Chicago 10, Ill.

Circle 212, inside back cover

MULTIPLE STAGE FLOW METER—Bulletin, 4 pp. Technical data and

BUILD YOUR BUSINESS ALONG THESE LINES

with BIJUR Automatic Lubrication

By incorporating the Bijur System into your designs, you can offer substantial operating economies which progressive users now demand. For example, in the metalworking field 75% of machinery users prefer "built-in" automatic lubrication on the machines they buy.

Costly hand lubrication is eliminated.

Production time is saved because machines are oiled while in operation.

Bijur Automatic Lubrication is the best friend a bearing ever had. Every bearing is automatically fed a metered shot of oil at predetermined intervals.

Inaccessible bearings that require regular lubrication are never neglected.

There can be no problem of work spoilage or bearing headaches caused by over lubrication.

Leading machine builders have standardized on Bijur for a quarter of a century. Bijur puts the accent on engineering design – to satisfy the specific requirements of your machines.

Our engineers can show you how to build increased dependability into your machines, whether they are in production or still on the board.

O-4

Write for literature and engineering data.

8370

BIJUR LUBRICATING CORPORATION

Rochelle Park, New Jersey

Pioneers in Automatic Lubrication

What do you know about the Moly-sulfide LUBRICANT?

A LITTLE DOES A LOT

You may have heard about a highly successful solid-film lubricant which is giving remarkable results in the shop and in the field.

In one 40-page booklet we have collected 154 detailed case-histories describing how difficult lubrication problems have been overcome by molybdenum sulfide. If you wish to be up to date about this solid-film lubricant, fill in the coupon below, attach it to your letterhead and send it off today.

THE LUBRICANT OF MANY USES

Moly-sulfide
A LITTLE DOES A LOT

Climax Molybdenum Company
500 Fifth Avenue
New York City · 36 · N · Y ·

SEND FOR THIS FREE BOOKLET TODAY

Name.....
Position.....
Company.....
Address.....

MOLY

PE-9 MS-3

Catalogs and Bulletins.....continued

illustrations include front and rear views, full size sections of the individually graduated 18 in. logarithmic scales, sectional view of the patented guides which are integral with the metering tube and a complete flow range chart which lists maximum capacities of various stages, with or without a bypass orifice. Commercial Research Laboratories, Inc., 20 Bartlett Ave., Detroit 3, Mich.

Circle 213, inside back cover

FINE WIRE, FOIL, RIBBON—Folder, 4 pp, describes a source of wire as fine as 0.004 in., Wollaston wire, Taylor process wire, resistance wire, thermo-element wire, metallic ribbon and foil. Baker & Co., Inc., 113 Astor St., Newark 5, N. J.

Circle 214, inside back cover

ACTUATOR MOTOR—Leaflet, 2 pp, provides all primary data required on this 25w miniature motor. Performance data, given in graphic form, covers speed, efficiency, output watts and input amperes over the torque output range to 4.25 in-oz. Dalmotor Co., 1362 Clay St., Santa Clara, Calif.

Circle 215, inside back cover

FASTENERS—Booklet, 12 pp, is made up of case history briefs, describing the designing and making of fastenings and special headed parts. National Screw & Mfg. Co., Cleveland 14, Ohio.

Circle 216, inside back cover

ELECTRICALLY VARIABLE INDUCTOR—Bulletin 4/654, 7 pp, is made up of individual sheets giving control characteristics on each of a series of seven inductors. Vari-L Co., Inc., P. O. Box 1433, Stamford, Conn.

Circle 217, inside back cover

VARIABLE SPEED MOTOR PULLEYS—Catalog, 22 pp, contains construction details, lubrication, controls available, instructions on how to select the proper unit, complete rating tables and dimensional diagrams. Reeves Pulley Co., Columbus, Ind.

Circle 218, inside back cover

CASTINGS — Zenith Foundry Co., 1501 S. 83 St., Milwaukee 14, Wis. Brochure, 18 pp, describes facilities and gives compositions for some cast irons.

Circle 219, inside back cover

When Your Problem is
WEIGHT REDUCTION
Your Answer is
Magnesium

Let's work together to design and make your product of the lightest structural metal. B&P's experience in all phases of Magnesium fabrication is unique in the industry. B&P has its own rolling mill; deep-drawing presses; stretch presses; spin lathes; blanking, routing, sawing, drilling, riveting, spot-and-arc-welding, and finishing equipment unexcelled in the industry.

This 8-page booklet illustrates B&P Magnesium facilities; gives strength-and-stiffness characteristics of structural metals, and suggests many ways that B&P can give you valuable assistance. We'll be glad to mail you this booklet.

LIGHTNESS B&P ...PLUS!

BROOKS and PERKINS Inc.

Pioneer Magnesium Fabricators
1956 W. Fort St. • TAshmoo 5-5900
DETROIT 16

Augmenting Miller's Quality-Famous Line of "Custom-Built" Cylinders...

Miller Stock AIR AND HYDRAULIC CYLINDERS

Available for *Immediate Delivery*...

in the popular sizes, mountings and prices listed below

Any of the *Interchangeable* "Stock" Mountings illustrated are attached by our factory to the "in-stock" Basic Model 53 with the tie rod nuts in a few moments. This gives you a selection of over 500 different "Stock" Cylinders for *immediate use*—and permits easy conversion to other models for *future re-use*. Thus, you save delivery and production time, investment cost and storage space.

PRICES OF MILLER "STOCK" CYLINDERS WITH MOUNTINGS ATTACHED AS ILLUSTRATED

(Prices on the separate mounting attachments for future re-use are available on request)

ORDER DIRECTLY FROM THIS LIST . . .

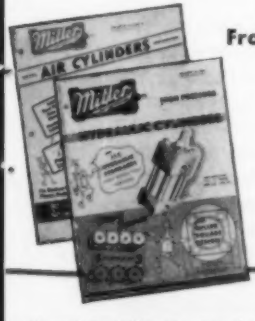
Shipment can be generally made within 24 hours after we receive your order. Prices are F. O. B. our plant.

			Basic Model 53		Model 77	Model 61	Model 62	Model 65	Model 66	Model 86
			Tie Rod Mounting		Foot Mounting	Rod End Flange	Cap End Flange	Rod End Flange	Cap End Flange	Pivot Mounting
Bore	Stroke	Cushion	AIR A53	HYD. H53	AIR A61 A77	HYD. H61 H77	AIR A62	HYD. H62 H65	AIR A66	HYD. H66 H86
1½"	2"	Non		$ 58.50		$ 61.40		$ 66.70		$ 72.85
1½"	4"	Non		60.70		63.60		68.90		75.05
1½"	6"	Non		62.90		65.80		71.10		77.25
1½"	8"	Non		65.10		68.00		73.30		79.45
1½"	11"	Non		68.40		71.30		76.60		82.75
2"	2"	Non	$ 37.70		$ 39.75		$ 42.30		$ 44.60	
2"	4"	Non	39.40		41.45		44.00		46.30	
2"	6"	Non	41.10		43.15		45.70		48.00	
2"	8"	Non	42.80		44.85		47.40		49.70	
2"	11"	Non	45.35		47.40		49.95		52.25	
2"	3"	Both	62.05	94.50	64.10	97.45	66.65	103.05	68.95	111.55
2"	5"	Both	63.75	97.00	65.80	99.95	68.35	105.55	70.65	114.05
2"	7"	Both	65.45	99.50	67.50	102.45	70.05	108.05	72.35	116.55
2"	9"	Both	67.15	102.00	69.20	104.95	71.75	110.55	74.05	119.05
2"	13"	Both	70.55	107.00	72.60	109.95	75.15	115.55	77.45	124.05
2½"	2"	Non	41.45	73.30	43.70	76.25	46.25	82.30	49.00	93.10
2½"	4"	Non	43.35	76.00	45.60	78.95	48.15	85.00	50.90	95.80
2½"	6"	Non	45.25	78.70	47.50	81.65	50.05	87.70	52.80	98.50
2½"	8"	Non	47.15	81.40	49.40	84.35	51.95	90.40	54.70	101.20
2½"	11"	Non	50.00	85.45	52.25	88.40	54.80	94.45	57.55	105.25
3¼"	3"	Both	77.80	126.85	80.35	131.20	84.15	138.60	87.70	149.95
3¼"	5"	Both	79.80	129.85	82.35	134.20	86.15	141.60	89.70	152.95
3¼"	7"	Both	81.80	132.85	84.35	137.20	88.15	144.60	91.70	155.95
3¼"	9"	Both	83.80	135.85	86.35	140.20	90.15	147.60	93.70	158.95
3¼"	13"	Both	87.80	141.85	90.35	146.20	94.15	153.60	97.70	164.95
4"	2"	Non	56.25	106.00	59.10	111.15	62.95	118.90	67.30	132.80
4"	4"	Non	58.85	109.40	61.70	114.55	65.55	122.30	69.90	136.20
4"	6"	Non	61.45	112.80	64.30	117.95	68.15	125.70	72.50	139.60
4"	8"	Non	64.05	116.20	66.90	121.35	70.75	129.10	75.10	143.00
4"	11"	Non	67.95	121.30	70.80	126.45	74.65	134.20	79.00	148.10
5"	3"	Both	98.25		101.40		105.25		110.60	
5"	5"	Both	101.65		104.80		108.65		114.00	
5"	7"	Both	105.05		108.20		112.05		117.40	
5"	9"	Both	108.45		111.60		115.45		120.80	
5"	13"	Both	115.25		118.40		122.25		127.60	
6"	2"	Non	80.60		83.95		87.85		94.15	
6"	4"	Non	84.90		88.25		92.15		98.45	
6"	6"	Non	89.20		92.55		96.45		102.75	
6"	8"	Non	93.50		96.85		100.75		107.05	
6"	11"	Non	99.95		103.30		107.20		113.50	
8"	3"	Both	157.35		161.05		167.90		174.95	
8"	5"	Both	162.45		166.15		173.00		180.05	
8"	7"	Both	167.55		171.25		178.10		185.15	
8"	9"	Both	172.65		176.35		183.20		190.25	
8"	13"	Both	182.85		186.55		193.40		200.45	

Miller "Stock" Cylinders fully meet the J.I.C. Standards and are identical to Miller "Custom-Built" Cylinders in design and construction.

"Stock" Air Cylinders are for 200 psi operation, "stock" hydraulic cylinders for 2000-3000 psi operation. Piston Rods of "Stock" Cylinders are "Style No. 2 Standard."

For complete descriptive and dimensional data on both "Stock" and "Custom-Built" Miller Cylinders, write for Bulletins A-105 and H-104 sent FREE on request.



Sales and Service From Coast to Coast!

Consult your local directory or write us direct for the name of our representative for your area

"Stock" Boosters, Too! Immediate delivery on Miller Dual Pressure Boosters; 5" bore, 1" ram (80 psi air input produces 2000 psi hydraulic output for driving one or more work cylinders simultaneously). In 6" and 12" strokes. Write for data and price

Complete Miller "custom-built" line includes: air cylinders, 1⅛" to 20" bores, 200 psi operation; low pressure hydraulic cylinders, 1½" to 6" bores for 500 psi operation, 8" to 14" bores for 250 psi operation; high pressure hydraulic cylinders, 1¾" to 12" bores, 2000-3000 psi operation. All mounting styles available. Also, a complete line of Fluid Pressure Boosters and Accumulators.

Miller

MILLER FLUID POWER CO.

(Formerly MILLER MOTOR COMPANY)

2002-04 N. Hawthorne Ave. Melrose Park, Ill.

AIR & HYDRAULIC CYLINDERS • BOOSTERS • ACCUMULATORS
COUNTERBALANCE CYLINDERS

need information on

electrical parts?

reach for your Product Design File

"...a great time-saver"

These manufacturers' catalogs are instantly available in Section 2 of your Product Design File:

A-P Controls Co.
Allen-Bradley Co.
Allis-Chalmers Co.
American Phenolic Corp.
Barber-Colman Co.
Barksdale Valves
Cannon Electric Co.
Century Electric Co.
Eagle Signal Corp.
Electric Specialty Co.
Electro-Snap Switch & Mfg. Co.
Elliott Company (Crocker-Wheeler Div.)
Emerson Electric Mfg. Co.
Fairchild Industries, Division Fairchild Camera & Instr. Corp.
Federal Telephone & Radio Co.
General Electric Co. Apparatus Mktg. Div. Const. Materials Div. Lamp Division Wiring Devices Dept.
General Radio Co.
Heinze Electric Co.
Howell Electric Motors Co.
Jefferson Electric Co.
Joy Mfg. Co.
Kato Engineering Co.
Master Appliance Mfg. Co.
Master Electric Co.
Mercoid Corp.
Mutual Industries
National Electrical Mfrs. Assn.
Ohmite Mfg. Co.
Radio Receptor Co.
Redmond Co., Inc.
Telechron Dept., General Electric Co.
Trombetta Solenoid Corp.
Wagner Electric Corp.
Ward Leonard Electric Co.
Westinghouse Air Brake Co.
Westinghouse Electric Corp.

In other sections of the File you will find additional catalogs containing useful information on product forms, characteristics, performance and use.

Sweet's Catalog Service

Division of
F. W. Dodge Corporation
119 West 40th Street,
New York 18, N. Y.

MEETINGS

Sept. 13-25

FIRST INTERNATIONAL INSTRUMENT CONGRESS & EXPOSITION, Philadelphia, Pa. Technical sessions will run through this period, while the exposition will open on Wednesday the 15th. Eight technical societies are cooperating with the Instrument Society of America in arranging the meeting. The ASME, for example, will devote their section to Aviation instruments, and the Society of Experimental Stress Analysis will include manufacturers of physical testing machines. At least 10 companies will conduct an instrument clinic on the latest analytical instruments. For advanced registration, contact: Dr. Axel H. Peterson, Mellon Institute, 4400 5th Ave., Pittsburgh 13, Pa.

Sept. 27-29

THE AMERICAN MANAGEMENT ASSOCIATIONS FALL PERSONNEL CONFERENCE, Hotel Astor, N. Y. More than 1,000 personnel and labor relations executives from the U. S. and Canada will attend. Topics to be discussed are: personnel reporting, executive selection; employee training; cost reduction; budgeting; human relations.

Sept. 28-Oct. 1

ASSOCIATION OF IRON AND STEEL ENGINEERS, Exposition and Convention, Public Auditorium, Cleveland, Ohio. A total of 16 sessions presenting a total of 48 technical papers has been arranged. There will be 4 Electrical sessions with 3 papers given at each; 2 lubrication sessions discussing "Non-flammable hydraulic Fluids," "Failures in Plain Bearings," "Stability of Lubricating Greases;" An Operating Practice Session; a Mechanical session; and others.

Oct. 4-6

TENTH ANNUAL NATIONAL ELECTRONICS CONFERENCE, Hotel Sherman, Chicago, Ill. The technical program offers 88 papers, supplemented by over 160 booth exhibits. Technical sessions are on: Magnetic Amplifiers; Circuit Theory; Instrumentation; Management of Small Research & Development Organization; Television; Radar & Navigation; Electron Tubes; Electronic Circuits; Computers; Electron Tube Reliability; Servomechanism and Control; Materials and Components; and others. Advance registration may be made by writing to the National Electronics Conference, Inc., 84 E. Randolph St., Chicago 1, Ill.

Oct. 5-9

SOCIETY OF AUTOMOTIVE ENGINEERS, National Aeronautics Meeting, Aircraft Production Forum, and Aircraft Engineering Display. Hotel Statler, Los Angeles, Cal.

Oct. 11-15

AIEE FALL MEETING at the Morrison Hotel, Chicago, Ill. Special emphasis will be on the electrical aspects of air transportation. The Power Div. will have sessions on: insulated conductors; protective devices; relays; rotating machinery; switch gear; and system engineering. The Industry & General Applications Div. will sponsor sessions on: Electro Thermal applications; Feedback Control Systems; General Industry Applications; and others.

Oct. 14-15

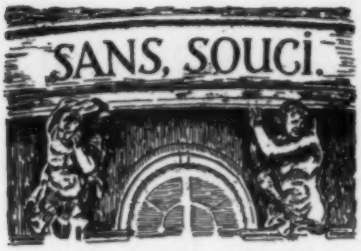
INDUSTRIAL HYDRAULICS NATIONAL CONFERENCE, Sheraton Hotel, Chicago. Sessions will be on: automotive applications; presses; pumps; aircraft; components; machine tools; materials handling; pneumatics; and fluid. The meeting is sponsored by the Illinois Institute of Tech. Graduate School, and Armour Research Foundation.

Oct. 18-19

LUBRICATION CONFERENCE, Lord Baltimore Hotel, Baltimore, Md. Sponsored by the ASME and The American Society of Lubrication Engineers. Five sessions on: Rolling element bearings; Hydro-dynamic Lubrication; Bearing Instability; Hydrostatic Bearings; and Materials and Lubrication.

Nov. 1-5

NATIONAL METAL CONGRESS AND EXPOSITION, The International Amphitheatre, Chicago, Ill. will house the Exposition, which will be occupied by 444 firms. The Congress will be held in the headquarter hotels of participating Societies: American Society for Metals, Palmer House; American Welding Society, Hotel Sherman; AIME, and Society for Non-Destructive Testing, Morrison Hotel. Sponsor is American Society of Metals, 7301 Euclid Ave., Cleveland 3, O.



Ad Libbing by the Editor

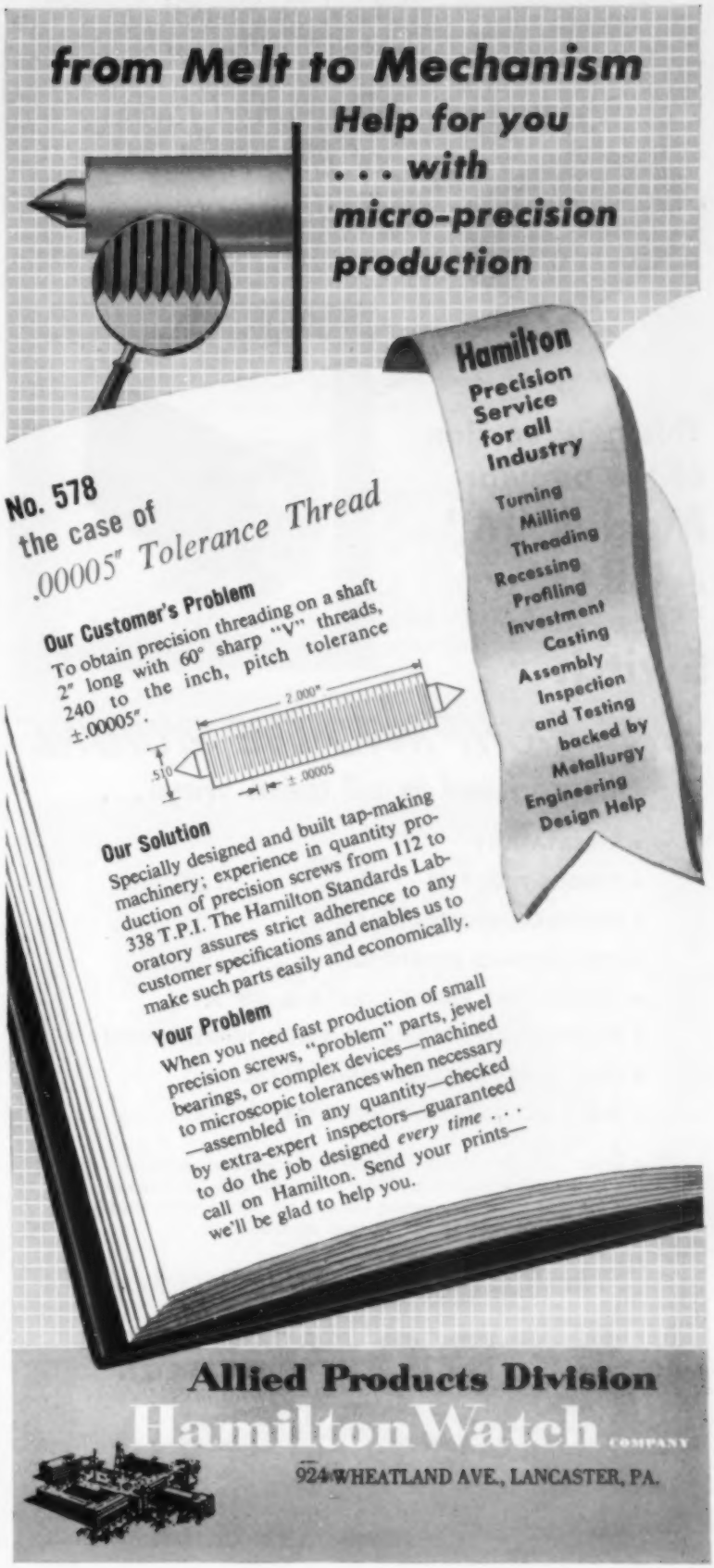
Among the readers of this column who write to me more or less regularly is one by the name of J. P. Laird. He is with the duPont Company, in one of their engineering departments. I write him, but am not punctual in answering his letters. This is not because I am not interested in what he writes. To the contrary. He sends me brief notes and clippings that are such good food for thought that it takes me a long time to digest them.

It has been almost a year since Mr. Laird sent me a copy of a talk given by Charles M. Cooper, director of the engineering research laboratory of the duPont experimental station at Wilmington, Delaware. I have read this speech several times and certain sections of it many times. It was delivered before a meeting of the Baltimore Section of the American Institute of Chemical Engineers and the Student Chapter of the University of Maryland. "Tools versus Information" was the title.

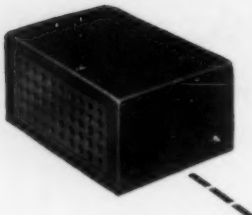
Here are a few of the gems in Dr. Cooper's address: "The responsible citizen somehow acquires the habits involved in thinking through personal and community problems. . . . The irresponsible person acquires habits which avoid thinking, which refuse to face facts, which postpone decision, and which accept as gospel the something-for-nothing promises of the demagogue."

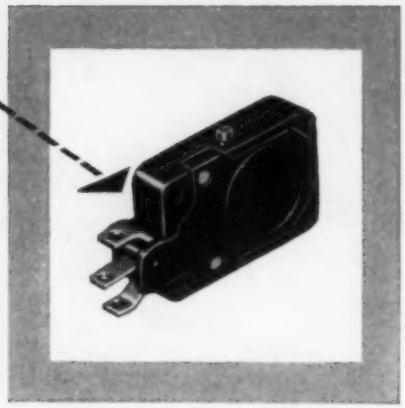
Mental habits and physical habits have much in common. Both require much practice. The person who has the habit of gathering the facts, analyzing the problem and making the correct decision has acquired that mental habit through long application and practice. Once the habit has been firmly established, "thinking comes easy."

Indeed, until a person has trained himself to the point where "thinking comes easy," he is likely to make grievous errors. The more effort a person must exert in his thinking, the less efficient and more clumsy it will be. It is just like physical operations. The


from Melt to Mechanism
Help for you
. . . with
micro-precision
production
Hamilton
Precision
Service
for all
Industry
Turning
Milling
Threading
Recessing
Profiling
Investment
Casting
Assembly
Inspection
and Testing
backed by
Metallurgy
Engineering
Design Help
No. 578
the case of
.00005" Tolerance Thread
Our Customer's Problem
To obtain precision threading on a shaft 2" long with 60° sharp "V" threads, 240 to the inch, pitch tolerance ±.00005".
2.000"
.510
± .00005
Our Solution
Specially designed and built tap-making machinery; experience in quantity production of precision screws from 112 to 338 T.P.I. The Hamilton Standards Laboratory assures strict adherence to any customer specifications and enables us to make such parts easily and economically.
Your Problem
When you need fast production of small precision screws, "problem" parts, jewel bearings, or complex devices—machined to microscopic tolerances when necessary —assembled in any quantity—checked by extra-expert inspectors—guaranteed to do the job designed every time . . . call on Hamilton. Send your prints— we'll be glad to help you.
Allied Products Division
Hamilton Watch COMPANY
924 WHEATLAND AVE., LANCASTER, PA.

Got A Small "Black Box" *Crammed full of Electronic Equipment?*





This new version of the popular Model "M" ACRO "Snap-Action" Switch

FITS RIGHT INTO THE PICTURE

Unsurpassed in all these ways...

- REPEATABILITY
- FUNGUS PROOF
- VIBRATION RESISTANT
- LOW CONTACT RESISTANCE
- TEMPERATURE RANGE +165° F. to -90° F.
- DIMENSIONALLY STABLE AT ABOVE TEMPERATURES
- WIDE RANGE OF OPERATING FORCES
- CLOSE MOVEMENT DIFFERENTIALS

The type "M" is only one of several thousand Acro-Mu snap action switch specifications. Write today for full information . . : or ask for free field engineering counsel on your switch problems. A new, complete catalog will be sent upon request.

"The Biggest Line of Little Switches"

ACRO MANUFACTURING COMPANY

ACRO SWITCH DIVISION

COLUMBUS 16, OHIO

Plants at Columbus and Hillsboro, Ohio

REPRESENTATIVES IN ALL PRINCIPAL CITIES

gymnast on the flying trapeze "flys through the air with the greatest of ease." If he could not do it as a habit he would probably land in a heap. The golfer who grits his teeth and tenses his muscles fails to hit the ball properly. The golf pro swings with ease and grace. Thinking can be easy and graceful.

Coming back to Dr. Cooper's address, here are a few more gems:

"There is much to be feared from a generation that will not think.

"One can learn a useful occupation and henceforth go through life letting other people make your decisions.

"There are no lengths to which the human mind will not go to avoid thinking."

How true this last statement is for many people. During the time I was working in shops I came across a highly political minded individual who somehow or other had climbed to the position of superintendent. He was a past master in the art of avoiding thinking, and he would go to any lengths to do so. One day I happened to be standing nearby when one of the foremen asked him for a decision concerning a job to be done.

"Jack!" cried the super, "You shouldn't ask me such detailed questions. That's your job to take care of little things like that. That's what you're paid for; that's why I have you here. You decide for yourself what you should do."

With that the super strode away. Now poor Jack was in a quandry. He did not have the production schedule information to enable him to make any decision. It just happened that Lee, a young fellow who had the job of production chasing was also standing nearby. He went to Jack, found out what the situation was, told Jack what to do and went along on his business.

Now Jack was so pleased he told all the other foremen about it and emphasized what a swell guy Lee was. And then all the foremen came to Lee when they wanted direction or information. And that is how Lee came to be the super.

Of course there is also promotion by politics. That includes damming others with faint praise, or half-spoken truths, "double-crossing" anyone who stands in the way, flattering the boss, cultivating him socially, and knifing him at the first promising opportunity.

—G.F.N.

ENGINEERING ABSTRACTS

Bonded Carbon-Graphite

Abstracted from "How, When and Where to Use Non-Metallic Materials—Carbon—Graphite," by Fremont F. Ruhl, Sls Mgr., United States Graphite Co., Div. of The Wickes Corp., Saginaw, Mich., presented before the Second Basic Materials Conference held concurrently with the Second Basic Materials Exposition, at Chicago, May 17-20, 1954.

BONDED CARBON-GRAPHITE is made from carbon and graphite powders, bonded with a carbonized hydrocarbon. A wide variety of carbons can make up the original ingredients, including coke, lampblack, charcoal, artificial and natural graphites. The binder is any hydrocarbon with a high coking value. The proper ingredients are in themselves so different that a wide range of grades can be obtained, possessing an equally wide range of physical properties. For instance, crude, coarse coke and petroleum pitch can be mixed, extruded and furnaced to give a relatively porous end product. However, it is entirely satisfactory as a carbon electrode. Conversely, fine, powdered charcoal and graphite, mixed, pulverized, compacted under extreme pressure and slowly furnaced, will yield a tight grained strong carbon-graphite. Either of these two different compositions can be furnaced further in an electric furnace to complete graphitization.

In the mixing of the carbon and graphite particles, with a hydrocarbon bond, it is necessary to attain a homogenous blend. Following controlled mixing, the granular solid must be pulverized to a closely controlled micron specification that permits maximum compacting to a uniform density. By using individual dies, with compacting pressures of from 20 to 30 tons per sq. in., these powdered solids are briquetted in a manner similar to that used in fabricating sintered metal parts. Particle distribution in the die is extremely important. Powdered solids will not flow like a liquid and, therefore, the contour variations that might be desired are often not recommended.

Following briquetting, the formed piece is furnaced, producing a porous or non-porous material with: high in-

Baldor BALTRIC® MOTORS

NEW NEMA Re-rated FRAMES

The new BALDOR Baltric motors—smaller NEMA frames • more horsepower • less weight • streamcooled • totally enclosed • high performance • cool operation • simple design • compact contour rugged construction • protected ball-bearings • polyphase and single phase • integral and fractional ratings.

★ MAY WE SEND YOU BULLETIN 400

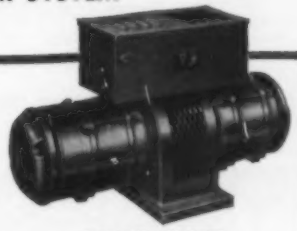
BALDOR BALTRIC MOTOR
3-phase and single phase

BALDOR ELECTRIC CO.
4353 DUNCAN AVE., ST. LOUIS 10, MO.

BALDOR ELECTRIC COMPANY • ST. LOUIS 10, MO.

Baldor ADJUSTABLE SPEED MOTOR SYSTEM

SPEED CONTROL



DELIVERS SPEEDS
from 0 to 2400 r.p.m.
in 16 steps of 150 r.p.m.
each forward or reverse

POWER UNITS

The BALDOR Simplified Adjustable Speed motor system operates from A.C. circuits; delivers speeds from 0 to 2400 rpm., with instant, smooth acceleration to each higher speed; instant, smooth dynamic braking to lower speeds or stop. Reverses instantly—even from full forward to full reverse. Separate components—mount in any position or distance apart. SIZES: to 3 h.p. for 2 or 3 phase operation; to 1½ h.p. for single phase operation.

ASK FOR BULLETIN No. SP-6

DRIVE MOTOR

BALDOR ELECTRIC COMPANY • ST. LOUIS 10, MO.

for a better grasp of any fastener problem—
CAMLOC
QUARTER-TURN FASTENERS

MEAN QUICK ACCESS. On panels, doors or covers, Camloc Fasteners provide positive locking by a quarter-turn with a screw driver or wing head. They're vibration-proof, because the action of cam, spring and detent creates a uniform locking torque that grips firmly. Camloc Quarter-Turn Fasteners cost less to install... minimize replacement... fewer do the job.

HEAVY DUTY LATCHES

SAFELY AND EASILY OPERATED. Where high shear-tension capacity is a factor... where opening and closing must be done under heavy loads—Camloc has the answer. Spring-loaded handle, retracting sheer pin, positive locking are among the many design advantages.

SPECIAL PURPOSE FASTENERS

SUITED TO YOUR NEEDS. In the electronics, aircraft, machinery and many other fields, leading original equipment manufacturers are calling on Camloc's Engineering Department to design special fasteners that increase accessibility.

If you have any fastener problem, write for our catalog or specific information.

soon! **STRESSED PANEL FASTENERS**
A complete departure from conventional fastening.
Write for illustrated brochure.

CAMLOC
FASTENER CORPORATION
62 Spring Valley Road, Paramus, N. J.
WEST COAST OFFICE: 5410 WILSHIRE BLVD., LOS ANGELES, CAL.

inherent hardness, relative high strength, heat resistance, thermal shock resistance, corrosion resistance, dimensional stability, low density and an extremely high melting point. Its limitations: it is basically brittle, with a low tensile strength, a low coefficient of thermal expansion and is limited in size to those pieces that can be practically produced on standard briquetting presses.

Limitations

Carbon-graphite, being basically brittle, must be handled with care and designed to eliminate thin sections, such as screw threads, narrow flanges, and thin wall sections. Since it is low in tensile, it must be used under compression in almost all applications. Its low coefficient of thermal expansion can often be a detriment in case it is applied as a high-temperature bearing. There is a four to one expansion differential between steel and carbon-graphite and hence on a high-temperature application, the shaft might expand at a greater rate and cause interference. A simple way to circumvent this disadvantage is to shrink fit the carbon-graphite in a metal band and thus make it conform to the expansion and contraction of the material used for the backing member. Size limitations can only be overcome by using multiples in series or by sectioning rings. Butt joint piston rings of 20 in. dia and metal-backed cylinder liners made in multiples are examples.

The disadvantage from a chemical standpoint can be briefly summed up in the fact that carbon graphite will oxidize to carbon dioxide in the presence of a strong oxidizing agent. Its oxidation rate is slow, but fuming nitric acid, sulfur trioxide, sodium hypochlorite and similar chemicals, and air over 700 F, will oxidize this material.

The advantages of carbon-graphite are an inherent high hardness of 100 Scleroscope "C", approximately the equivalent of 65 Rockwell "C". Carbon-graphite is light, weighing about one ounce per cubic inch and has a density of 1.7. Its dimensional stability is excellent. Carbon-graphite sublimes at about 6,300 F and has a compressive strength in some grades of approximately 35,000 lb psi. From a chemical standpoint, it is corrosion-resistant to almost all organic compounds and is not affected by a wide range of inorganic materials. It may be used in pure oxygen below 400 F and in a neutral or reducing atmos-

phere at extremely high temperatures and still retain its strength. From strictly a mechanical standpoint, it will not handle harsh abrasives. It is good in fretting corrosion and has high wearing characteristics.

Seal Design

The non-melting quality of carbon-graphite, its high surface hardness and its ability to be lapped flat and stay flat, are the key reasons why this material is so widely used for face-type rubbing seals. Special seal designs have been made to handle dry air at 500 F, 100 psi and 200 ft per second. Seal life with gases or liquids not containing abrasive solids is in the order of 20,000 hr on a number of normal applications.

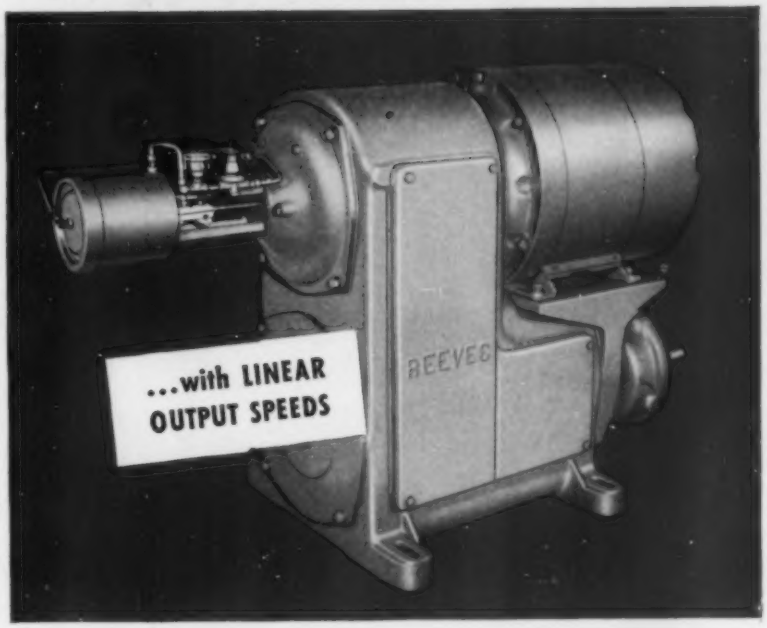
In one particular rotary pressure joint, a carbon-graphite bearing and seal assist in feeding steam or other fluids from a stationary to a rotating piece of equipment. Lubrication, other than the fluid handled, cannot be tolerated. Temperatures up to 650 F must be accommodated by both the bearing and the seal. Speeds and pressures range up to 600 fpm and 400 psi. Carbon-graphite, as a material, fills this important function by its ability to run dry or with fluid lubrication and be corrosion resistant. Relatively large cross sections can be used for this severe service. Life figures in years are often realized, thus proving the wear resistance.

Quite a bite of latitude can be used in seal designs in regard to most all tolerances including lapping. The conformability of carbon-graphite is excellent and hence a commercial lap is often just as satisfactory as a three light band lapping specification. Material selection on the other hand is extremely important. Porosity control and uniformity are a must. Heavy lubricating oils and greases that are subject to breakdown by temperature present quite a problem. Conversely, carbon-graphite will give excellent performance as a bearing or a seal when used at 250 to 500 F with top quality non-gumming oils.

Probably the best lubricant for carbon-graphite is clear, pure water. The new submersible deep well pump-motor units that permit pumping water from a deep supply by placing the pump at the bottom of the well typify this application.

In these units, we have the ultimate in design, wherein carbon-graphite is

New *Automatic Speed* Control for Continuous Processing



REEVES

Auto-Pneumatic Control

• Now with the REEVES Vari-Speed Motodrive equipped with the new sensitive Auto-Pneumatic control, you can automatically control continuous processes involving the regulation of heat, liquid level, pressure, temperature, flow, and many other variables. Positive direct connection from the pneumatic instrument to the Auto-Pneumatic control assures accurate and sensitive speed regulation.

Exclusive REEVES cam design provides linear output speeds so necessary for delicate proportioning processes . . . maintains the greatest accuracy while regulating or maintaining any speed throughout the range of the Motodrive.

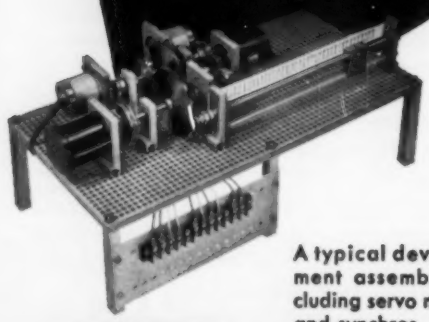
REEVES Auto-Pneumatic Control assures maximum efficiency and economy in industrial processes . . . means outstanding savings for you in material, fuel and labor costs plus continuous uniformity of your product or process. Write today for complete information.

REEVES PULLEY COMPANY • COLUMBUS, INDIANA

Send today for
BULLETIN K13-M542

FAST...economical assembly of motors, gear trains, electro-mechanical computing and transmission devices with mechanical development apparatus

Servomechanisms, Inc., versatile Mechanical Development Apparatus is intended for numerous applications in the research, instrumentation, and servo control fields. Typical applications of these precision built components include analog computers, signal generators, process programmers ... Assembly is made with standard tools ... each component is designed for repeated use.



A typical development assembly including servo motors and synchros.

Foundation Boards and Legs
Mounting and Bearing Blocks
Stainless Steel Shafts and Gears
Limit stop, Couplings, Lead screws, Clutch, Dials, Cams, Switch

SERVOmechaNISMS INC.
PACKAGED FUNCTIONAL COMPONENTS

Write for Descriptive literature MDA-200

Components Division, 625 Main Street, Westbury, N.Y.

West Coast Division, 316 Washington Street, El Segundo, California

used with a very good corrosionresistant, stainless-steel shafting material. Clear, pure water sealed in the unit provides life-time lubrication. A flat, lapped thrust washer takes the end thrust by using a Kingsbury type steel slipper bearing for an unusually low coefficient of friction of approximately 0.002 in. With care in assembly, good, smooth mating surfaces of about 10 rms and controlled running clearances, life figures of 8,000 hr and more are attained without any measurable wear. Lubrication is metered through the pores on some thrust bearings, permitting a PV condition of over 1,000,000.

Digests of Key Papers Welding Society Meeting Buffalo, N. Y., May 4-7

"Effect of Alloying Elements on Welds in Titanium." by G. E. Faulkner, Battelle Memorial Institute.

Welding studies were conducted on series of titanium-vanadium alloys, titanium-aluminum alloys, and alloys containing combinations of the principal beta-stabilizing elements, chromium, iron, manganese, molybdenum, and vanadium, and combinations of the beta-stabilizing elements and aluminum. These tests were conducted to obtain further information concerning the effects of alloying elements on welds in titanium.

Inert-gas-shielded tungsten-arc welds were made in $\frac{1}{8}$, $\frac{1}{4}$ and $\frac{1}{2}$ in. thick plates of these alloys. The welds were tested for bend ductility, notch toughness, hardness and microstructure. Tensile tests were made on unwelded plates in each of the alloys.

These data were compared with previously published data on the effects of chromium, iron, manganese and molybdenum on welds in titanium alloys. Vanadium had an effect on the weld joint properties of titanium alloys similar to the other beta-stabilizing elements. The ductility of welds in the titanium-vanadium alloys decreased with increasing alloy content and became law when the vanadium content approached 5 per cent. However, the ductility of the welds could be improved by heat treatment.

The ductility of welds in the aluminum alloys was good in alloys containing up to 5 per cent aluminum and limited aluminum additions to alloys

containing beta-stabilizing elements increased the strength but had no appreciable affect on weld-joint properties.

Welded joints in alloys containing combinations of beta-stabilizing elements and combinations of one beta-stabilizing element and aluminum had properties similar to welds in alloys containing only one beta-stabilizer.

"HIGH TEMPERATURE ALLOY DIFFUSION BRAZING OF TITANIUM," by Roger A. Long and Robert R. Ruppender, Ferrotherm Co.

THE FURNACE BRAZING of titanium requires basically a time cycle longer than that of torch or induction brazing. The use, therefore, of a fusion brazing alloy instead of a diffusion filler alloy would tend to eliminate the formation of intermetallic layers of brittle compounds which form as a time function.

Development was based on the above as well as on flow temperature of the filler metal, time at temperature and the necessary ability of the brazing alloy to dissolve thin oxide films.

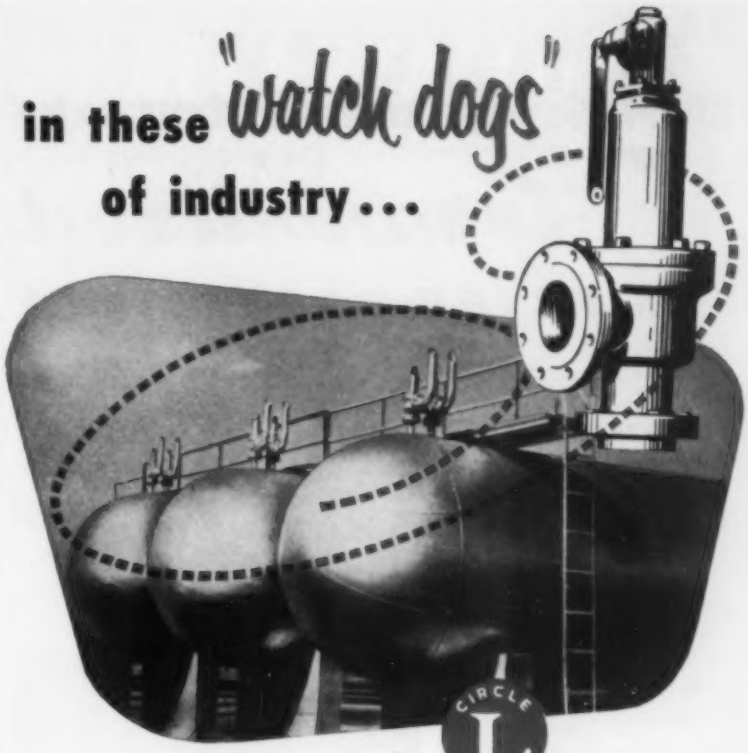
The nickel-titanium combination seemed to offer the least resistance to development. The system contained two eutectic compositions of somewhat low melting points. Utilizing these eutectics as a base alloy, elements were added to lower the flow of temperature, increase wettability, and maintain an even hardness gradient across the brazed joint area.

Ultimate shear strengths varied from 40,000 psi to 70,000 psi depending on the alloy utilized. Failures occurred outside the joint area and in the parent metal. Brittleness in the joint area was not determined in these tests.

"BRAZING MOLYBDENUM FOR HIGH-TEMPERATURE SERVICE," by M. I. Jacobson and D. C. Martin, Battelle Memorial Institute.

THE BRAZING METHODS that were investigated included vacuum brazing in an Inconel retort, oxyacetylene torch brazing with a flux, tungsten-arc torch brazing in a helium atmosphere, induction brazing in vacuum, and induction brazing in argon. Sixteen high-temperature brazing alloys that had melting points of 1,800 F or higher were studied. The major factors that were determined were the ability of

in these "watch dogs" of industry...



LEBANON STEEL Castings are at work

SAFETY valves, those "watch dogs" of industry, are particularly important in chemical, refinery and power plants. Farris Safety and Relief Valves, for instance, are "on guard" 24 hours a day, protecting workers, protecting equipment, and assuring uninterrupted plant operations. Lebanon CIRCLE Ⓛ castings, important parts of these valves, are produced in several special alloys including CIRCLE Ⓛ-17*, a hardenable, corrosion-resistant, stainless steel with exceptional strength at elevated temperatures. Selecting these Lebanon casting materials added greater reliability to Safety and Relief Valves operating in lines handling steam, corrosive fluids and gases. These Safety and Relief Valves are manufactured by the Farris Engineering Corporation, Palisades Park, N. J.

Lebanon's experienced craftsmen produce castings in a wide range of materials . . . flexibility and control that provide truly dependable products.

*Lebanon's designation for Armco's 17-4-PH, produced under license by Armco Steel Corporation.

See—STEEL WITH A THOUSAND QUALITIES—37 min., 16 mm, semi-technical, full-color sound film on the making of steel castings. For information write: Dept. C, Lebanon Steel Foundry.

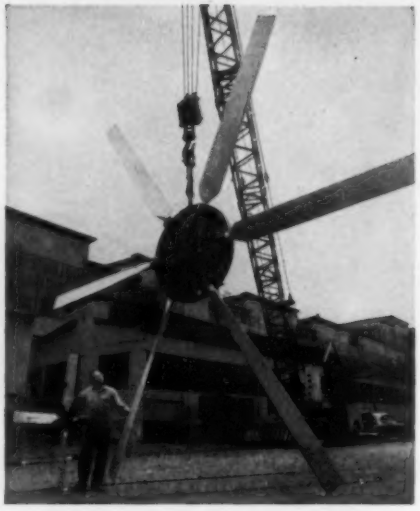
LEBANON Castings

CARBON, SPECIAL ALLOY AND STAINLESS STEEL

LEBANON STEEL FOUNDRY LEBANON, PA.

KOPPERS Aeromaster FANS ARE Granodized WITH GRANODINE®
FOR EXTRA PROTECTION

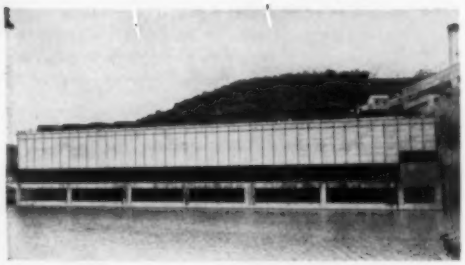
KOPPERS Precision-Engineered Air Delivery increases the efficiency of air flow in industrial cooling systems. Basic element is the Aeromaster Fan, and this unit is operated continuously, sometimes under severe conditions. Dependable, efficient operation is a "must".



"Granodine" application on welded 54" Hub for Aeromaster 6-bladed 22-foot Cooling Tower Fan.

KOPPERS uses "Granodine" No. 50 to coat the 54-inch diameter hub of the 22-foot diameter fan shown above. "Granodine" phosphate coatings provide a "tooth" for adhesion of subsequent finishes and protect the underlying metal so that rust will not spread if these finishes are cracked or nicked.

"Granodine"® anchors the finish.



Aeromaster 22-foot Fans provide continuous air flow in C. H. Wheeler Cooling Tower at Pennsylvania Electric Company's Shawville Station, Clearfield, Pa.

Pioneering Research and Development Since 1914

AMERICAN CHEMICAL PAINT COMPANY

CHEMICALS ACP PROCESSES

General Offices: Ambler, Penna.

CHEMICALS ACP PROCESSES

Detroit, Michigan **Niles, California** **Windsor, Ontario**

the alloy to braze molybdenum, the brazing techniques required to obtain good joints, and the properties of brazed joints in commercial molybde num sheet at room temperature and at a temperature of 1,800 F. Induction brazed joints in commercial molybde- the most satisfactory brazing method from the standpoint of braze quality and practicability. Room-temperature strengths of brazed joints were generally low because of recrystallization of the base metal and because of the notch effects inherent in the joints. Short-time tension tests at 1,800 F of joints induction brazed in argon showed that the best cobalt-base brazing alloy was Haynes Alloy 25 which produced a braze with a shear strength of 14,250 psi. The best noncobalt-base brazing alloy was Inconel which produced a braze with a shear strength of 18,800 psi. The 100 hr shear strength at 1,800 F of joints induction brazed with Inconel was found to be 5,000 psi, while the 100 hr shear strength of joints induction brazed with Haynes Alloy 25 was 4,500 psi.

"CALCULATION OF WELDED JOINTS," by C. G. J. Vreedenburgh, Prof. of Applied Mechanics, Tech. University of Delft, Netherlands.

FOR THE CALCULATION OF the strength of welded joints use has been made of a critical surface of the ultimately allowable values for the average stresses either in the smallest longitudinal section (throat section) or cross-section of the weld.

In statically loaded structures the shape of the critical limit-curve for loads perpendicular to the longitudinal axis of the weld can be deduced from the experiments of the National Council for Applied Scientific Research in the Netherlands.

Starting from the average stress in the throat-section of the weld no theory of rupture or plastic flow has up to now given a satisfactory explanation of all symptoms of rupture observed in end-fillet welds at the moment of fracture, which is partly caused by the uneven distribution of stresses.

In comparison with Kist's method of calculation, in use at present, the principles here presented allow not only some simplification but above all economy in the case of weld sections loaded in shearing or compression.

NEW BOOKS

Diesel and High Compression Gas Engines

EDGAR J. KATES, *A.B., M.E., Consulting Engineer, New York City, Fellow and Officer, the American Society of Mechanical Engineers.* 5½ x 8½ *in.*, 396 *pp. Published by the American Technical Society,* 848 *East* 58*th St., Chicago* 37, *Ill.* $5.50.

This book is intended to give the nontechnical as well as the technical reader a basic understanding of the principles, construction and operation of diesel engines. An explanation of another related engine is included. This is the gaseous fuel power plant, of both the diesel and the spark ignited types.

The design and construction characteristics of various types of engines are described. An analysis of fuels and how they produce power is given and the role of engine accessories and controls is also discussed.

Heat Transmission

WILLIAM H. MCADAMS, *Professor of Chemical Engineering, MIT. Sponsored by the Committee on Heat Transmission, National Research Council.* 6½ x 9½ *in.*, 532 *pp. Published by the McGraw-Hill Book Co., Inc.,* 330 *West* 42 *St., New York* 36, *N. Y.*, $8.50.

This well-known text and reference book for practicing engineers and students of all phases of engineering has been thoroughly revised to reflect the progress made in the field of heat transfer. Old material has been simplified and new information added. The text has been improved by more extensive use of analytical methods, expanded derivations and the use of greater descriptive passages. The book is designed to provide an authoritative, up-to-date treatment of all phases of heat transfer, with a critical evaluation of the data.

One of the most important changes in the third edition is the revision of Chapter IV, "Radiant-Heat Transmission," by Professor H. C. Hottel, of the Massachusetts Institute of Technology. The section on gas radiation includes new charts for evaluating the emis-

ATLANTALLOY
PLASTER MOLD CASTINGS CAN SOLVE YOUR DESIGN PROBLEMS

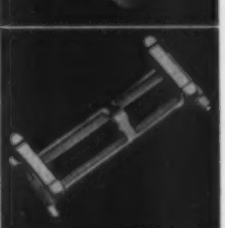
Atlantalloy plaster mold precision castings provide non-ferrous castings cast to ordinary machining tolerances, effecting definite savings in machining and other costly operations. Atlantalloys are characterized by high strength, durability, and many other advantages.

NO. 10 YELLOW BRASS Atlantalloy — An all-purpose alloy for brush boxes, gears, levers, etc. Fine grain, clean, smooth surfaces assure tightness. Easily machined. Free from porosity. Fatigue resistant.

NO. 20 ALUMINUM BRONZE Atlantalloy — Excellent for gears and bearings. Strong, light, zinc-free. Highly resistant to corrosion. Machines well.

NO. 31 High Tensile MANGANESE BRONZE Atlantalloy — High strength engineering material for gears, valve bodies, electrical mechanisms, etc. Extremely durable. No heat treatment needed. Can be cast in thin sections.

NO. 40 High Strength ALUMINUM "Tenzalloy" — Attains high strength through natural aging. Free from internal stress and skin hardness. Ideal for machining.



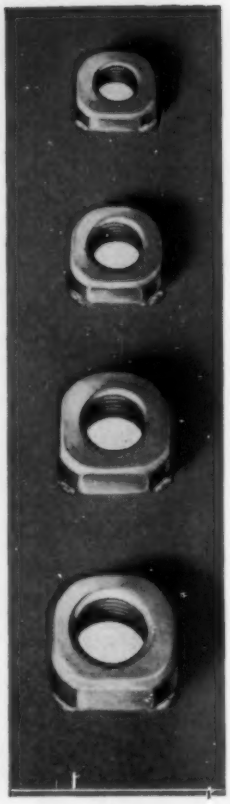
NO. 60 ALUMINUM Atlantalloy — Perfect as instrument alloy. Fully uniform with no internal strain. Can be used for accurate, thin-sectioned castings.

WRITE.. for free copy of "Quality Precision Castings for Industry." Get full data on our plaster mold process and alloys.

ATLANTIC CASTING and ENGINEERING CORP.
Established 1937
810 Bloomfield Avenue • Clifton N J • PRescott 9-2450

For Speedy... Economical Assembly

SPECIFY MIDLAND Welding Nuts



Ideal for Hard-To-Get-At Places ...Will Not Work Loose or Rattle!

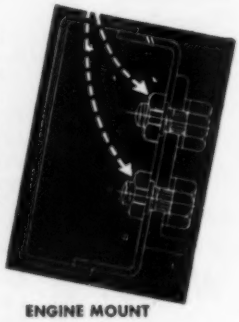
Whether you're designing a product or building it, the Midland Welding Nut is the answer to the problem of accurately and securely fastening metal parts into a main assembly . . . speedily, economically.

It is welded to the parts so that a bolt can be turned into it without the need for any device to hold it and keep it from turning.

This frequently means that one man can do the work of two, for with an ordinary bolt and nut one man usually has to hold the nut in place while a second man turns the bolt into it.

Midland Welding Nuts are perfect, too, for those hard-to-get-at places in assembly operations. Welded in advance to those inside spots where it is difficult —or *impossible*—for hands or tools to reach, Midland Welding Nuts hold fast while bolts are turned into them.

Write or phone for complete information *today!*



ENGINE MOUNT

The MIDLAND STEEL PRODUCTS COMPANY
6660 Mt. Elliott Avenue • Detroit 11, Michigan
Export Department: 38 Pearl St., New York, N.Y.

Manufacturers of

AUTOMOBILE AND TRUCK FRAMES | AIR AND VACUUM POWER BRAKES | AIR AND ELECTRO-PNEUMATIC DOOR CONTROLS

sivity due to sulfur dioxide, carbon monoxide and ammonia; and the carbon dioxide and water-vapor charts have been expanded to permit estimation of radiation at rocket gas temperatures. The treatment of radiation exchange in a multi-surface gray enclosure containing a non-gray absorbing and emitting gas has been generalized by the use of determinants to eliminate any restriction on number of surface zones, and the new method permits a solution of problems previously beyond the capability of the engineer to handle them. New chapters cover "Natural Convection," "Compact Exchangers-Packed and Fluidized Systems," and "High-Velocity Flow; Rarefied Gases," including material heretofore available only in widely scattered sources.

Hydraulic Systems & Equipment

R. HADEKEL. 6 x 9 *in.*, 224 *pp. Published by the Cambridge University Press, 32 East 57th St., New York 22, N. Y.* $3.75.

For an engineering field in which there has, as yet, been a minimum number of books published, this publication predicts the increasing amount of information which will be made available in the next few years. From the viewpoint of technical knowledge, this book represents a significant step to correlate basic facts of importance to the designer of hydraulic systems and equipment.

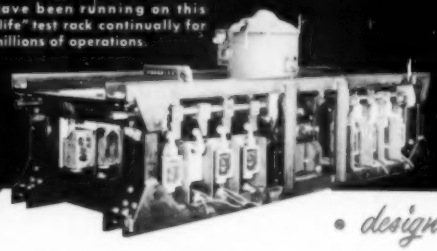
Material contained in the publication is based on the reader having a fundamental knowledge of the elements of fluid mechanics. It covers that ground which can make use of known data to solve oil-hydraulic problems peculiar to specific applications. By treating generalized problems, the author attempts to lead the reader through a reverse path to the understanding and solution of particular problems.

The contents of the book are divided into fourteen chapters with a bibliography which offers several helpful reference suggestions to readers concerned with hydraulics for control and positioning applications. Subject matter discusses first the basic elements of hydraulic systems and then progresses into the field of control gear principles and circuit principle. In sequence follow chapters on idling problems, open center and all types of systems, pilot

NEW

CLARK *Type DM* MACHINE LIMIT SWITCH

CLARK Type DM Limit Switches have been running on this "life" test rack continually for millions of operations.



• designed and built for dependability and longer life-

Our design engineers were given the assignment of developing a new heavy-duty machine limit switch to meet the exacting needs of modern industry. Primary requisites were dependability, accuracy, durability and versatility. They created a design that is rugged, simple and 100% functional. They selected materials for the working components that hold up indefinitely under the most severe punishment. They employed sound, mechanical principles to provide positive, accurate, trouble-free operation, and added features to make the switch as nearly "fail-safe" as possible.

Pilot models were subjected to severe breakdown tests, and changes made as indicated. When our high standards for performance and durability were finally met, the initial production run was made. The first production units were placed on the test rack illustrated, and have been operating continuously ever since.

THE CLARK CONTROLLER CO.

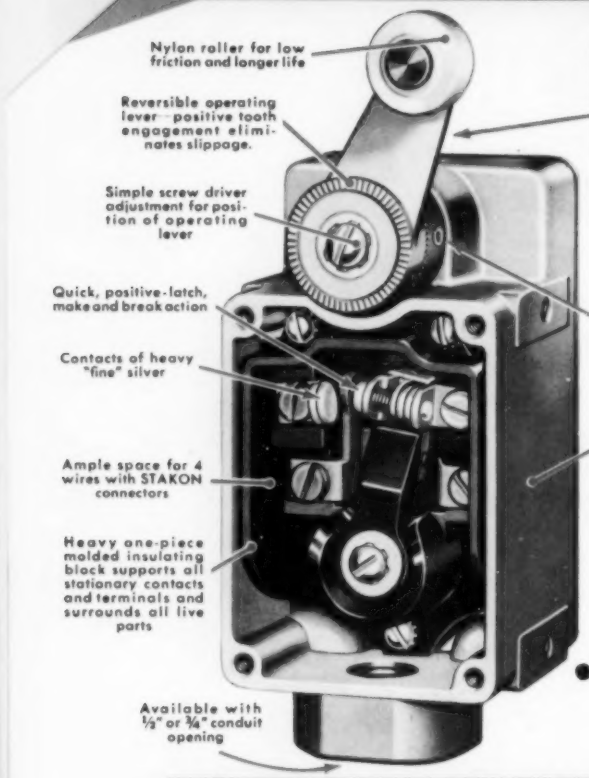
ENGINEERED ELECTRICAL CONTROL • 1146 EAST 152ND STREET, CLEVELAND 10, OHIO

See other side for further details

CLARK *Type DM* LIMIT SWITCH

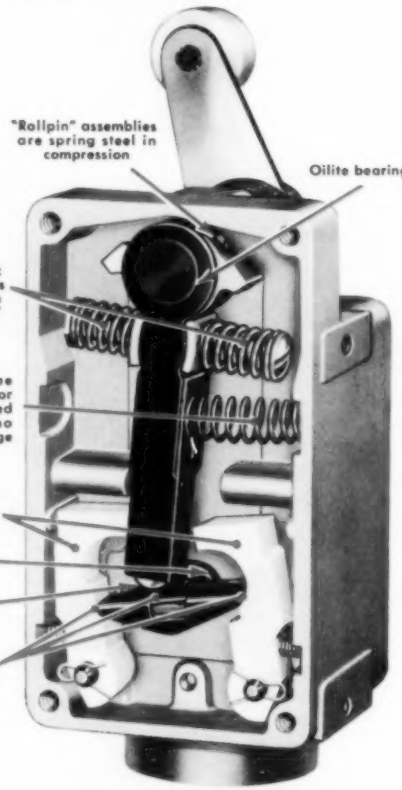
built for RUGGED SERVICE

VERSATILITY • LONG LIFE • ACCURACY


Nylon roller for low friction and longer life
Reversible operating lever—positive tooth engagement eliminates slippage.
Simple screw driver adjustment for position of operating lever
Quick, positive-latch, make and break action
Contacts of heavy "fine" silver
Ample space for 4 wires with STAKON connectors
Heavy one-piece molded insulating block supports all stationary contacts and terminals and surrounds all live parts
Available with ½" or ¾" conduit opening
"Rollpin" assemblies are spring steel in compression
NEMA Type 5 dust-tight, oil-tight enclosure
• Areas subjected to arc deterioration protected with glass-melamine plates
• All springs are in compression
• Electrical and mechanical sides of switch are completely isolated

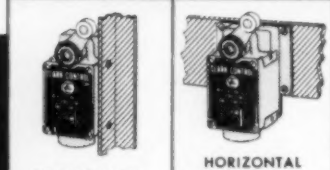
OPERATING LEVERS
8 TYPES AVAILABLE FROM STOCK

CLARK Type DM LIMIT SWITCHES are simply built, with a minimum number of parts. They are designed for one purpose: to provide dependable, accurate, trouble-free operation for a long life. All latch and trip-bearing surfaces are nylon to steel for minimum wear. All springs are in compression for greatest safety—they cannot be overloaded.

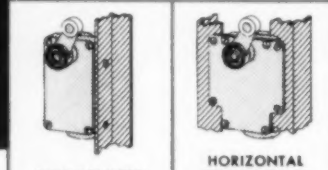

"Rollpin" assemblies are spring steel in compression
Oilite bearings
Double concentric over-travel springs in compression for "fail-safe" operation
Return spring can be used on either side or removed for maintained contact—requires no tools to remove, change or replace
Nylon Latches with exceptional wearing qualities
Oilite bearings
Nylon spring-loaded contact operator
All latch and trip bearing surfaces are nylon to steel

REGULAR AND REVERSE LEVER TYPES
—can be mounted in any position

REGULAR MOUNTING TYPES



REVERSE LEVER MOUNTING TYPES



Six styles of back covers or mounting plates are available for an infinite variety of mounting arrangements.

Insist on CLARK Type DM Limit Switches for more dependable, longer life operation on all your new machines and for replacement of unreliable or worn out switches on equipment now in use.

THE CLARK CONTROLLER COMPANY
1146 EAST 152nd STREET • CLEVELAND 10, OHIO

Please send me Bulletin 102 DM describing the new CLARK Type DM Limit Switch.

NAME _____

TYPE OF BUSINESS _____

COMPANY _____

ADDRESS _____

CITY AND STATE _____

Send for 4-page descriptive bulletin giving full specifications and ratings. Use this coupon.

and electrical control, automatic sequence systems, power economy and energy storage, variable delivery pumps and continuous motors, control of load, speed and position, general design considerations, seals, jacks and accumulators, valve design and piping.

Of special interest is the chapter on control of load, speed and position and that on general design considerations. While the latter chapter discusses the hydraulic system as a whole and the factors involved in selecting pressures and components, the control chapter gets into hydraulic control systems which are of increasing importance to designers.

In its scope, the book will perform two functions: (1) it will be of aid to the young hydraulic engineer entering the field; and (2) it can serve as reference material for the more experienced designer.

Practical Gear Design

D. W. DUDLEY, *Supervisor, Gear Advance and Development Engineering, General Electric Co.* 6 x 9 *in.*, 335 *pp. Published by McGraw-Hill Book Co., Inc.*, 330 *West* 42*nd St., New York* 36, *N. Y.* $7.

The recent graduate or general engineer who is not a gear specialist finds a serious gap in reference material on the design and production of various types of gearing. From the typical college machine design textbooks which treat only the bare fundamentals of gearing, there is next to nothing until the reader reaches the advanced level covered by the well-known works of Earle Buckingham. About the only material worthy of mention in this area is that presented as papers for the engineering societies and articles published in trade magazines.

The primary aim of this book appears to be the presentation of an integrated discussion of the geometry of gear design, manufacturing methods and causes of gear failure in a more comprehensive form than would be attempted in an article or technical paper. Throughout the book, the author stresses the practical aspects of gear design based on the limitations and availability of materials, machine tools, and tooling setups. In line with this objective, equations, curve sheets, and tables are presented in such a form and modified by text and experience to be

Remember!

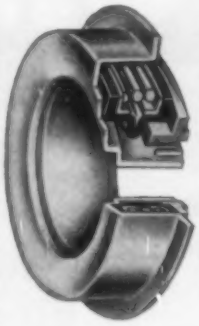
When you specify Mechanical Seals...

JOHN CRANE

can supply the exact seal you require

You can achieve the sealing efficiency you want . . . eliminate specification problems . . . work unhampered from drawing board to production—when you work hand-in-hand with "John Crane's" experienced engineering staff and available facilities.

Get quick, finger tip information on "John Crane's" complete line of high production mechanical seals—for every conceivable service—to meet your particular needs. Send now for illustrated technical catalog. It's your's upon request.

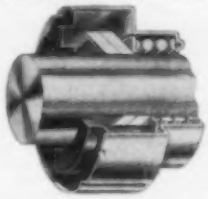


TYPE 6-A

Pressed-in packaged unit recommended for small shafts on hot or cold water, oil, gasoline or soapy liquids . . . pressures to 75 psi . . . temperatures from —65° F. to +220° F. Available in stainless steel or bronze.

TYPE 11-A

Pressed-in packaged unit with spring inside synthetic rubber bellows to protect against corrosion. For hot or cold water, oil, gasoline or soapy liquids . . . pressures to 35 psi . . . temperatures from —65° F. to +212° F.



TYPE 19

An all-purpose seal suitable for handling practically any liquid or gas, including highly corrosive acids and oils.

Low or high temperatures from —100° F. to +450° F. . . . pressures to 200 psi. Incorporates highly efficient sealing cones made of Du Pont's Teflon, which is inert to practically all chemicals.

Crane Packing Company, 1845 Cuyler Ave., Chicago 13, Illinois

In Canada: Crane Packing Co., Ltd., 617 Parkdale Ave., N., Hamilton, Ont.

JOHN CRANE **CRANE PACKING COMPANY**

LOOK INTO YOUR
Speed Reducer Cost

Ohio double speed reducer DPL series, three sizes, ratios, 100-1 to 4000-1. From ¼ to 2½ horse power.

CHECK THESE ADVANTAGES WITH OHIO GEAR

- Quality
- Design
- Dependability
- Purchase Price
- Delivery

Ohio Speed Reducers are famous for their performance. You will find them operating in every great industrial center in the world. Perhaps Ohio Gear can serve you as well. There is a Distributor conveniently located near you—or write to Ohio Gear direct.

Ohio speed reducers HU series worm on top, five sizes. Single reduction reducers, input shaft is above the output shaft. Ratios, 5-1 to 100-1. From ¼ to 15 horse power.

ESTABLISHED 1915
OHIO GEARS

THE OHIO GEAR COMPANY, 1325 East 179th St., Cleveland 10, Ohio

of maximum use in actual design problems. The data on gear manufacturing methods includes a comprehensive treatment of the advantages and limitations of such advancements as rotary and rack shaving. The material on kinds and causes of gear failure should prove useful to many readers.

Metals and How to Weld Them

T. B. JEFFERSON, *Editor, Welding Engineer, and* GORHAM WOODS, *Metallurgist, Cleveland, Ohio.* 5½ x 8½ *in.*, 322 *pp. Published by James F. Lincoln Arc Welding Foundation, Cleveland* 17, *Ohio.* $2.

Written for those who need to know what takes place in metals when welds are made. Designed as a text or for self-study and reference purposes.

All welding processes and their uses are described, with emphasis on the basic metallurgy and the metals that may be welded. The discussions of metallurgy included are simplified.

Welding of the various groups of metals are discussed in separate chapters. A special chapter is devoted to hard-facing and another discusses the principal elements of good welding practice. A glossary of welding terms and a number of tables of useful information pertaining to welding are included in the index.

Adhesive Bonding of Metals

GEORGE EPSTEIN, *Research Engr., North American Aviation, Inc., Downey, Calif. Reinhold Pilot Book,* 4½ x 6¾ *in.*, 218 *pp. Published by Reinhold Publishing Corp., Book Div.,* 330 *West* 42 *St., New York* 36, *N. Y.*, $2.95.

The purpose of this book is to permit an engineer or technician, concerned with the problem of joining two materials, to determine if an adhesive-bonded joint will be advantageous, what type of adhesive to select, how to employ the adhesive, and how to design the joint for optimum performance. In particular, adhesives are considered which are most generally employed with metals.

In order to familiarize the reader with the physical and chemical properties of adhesives, a fairly comprehensive discussion is given to the chemistry and formulation of adhesives,

especially in relation to the properties of the cured adhesive bonds. Extensive treatment is also presented of the various factors effecting the strength of adhesive bonds, including the concept of joint factor and its use. Sandwich construction is considered in some detail, especially with reference to the roles played by adhesives.

An entire chapter is devoted to elevated-temperature-resistant adhesives for metals. Other chapters include: The Place of Industrial Adhesives in Metal Fabrication; Basic Materials for Adhesives; Formulation: Some Typical Adhesives; Design and Testing of Adhesive Joints; Bonding Techniques; Adhesives for Metals in Sandwich Constructions. Appendices include: Requirements of Specification (MIL-A-8331 USAF); Mechanical Properties; and Selected References.

Noise

ALDERT VAN DER ZIEL, *Professor of Electrical Engineering, University of Minnesota.* 6 x 8½ *in.*, 450 *pp. Published by Prentice-Hall, Inc.*, 70 *Fifth Ave., New York* 11, *N. Y.* $10.35.

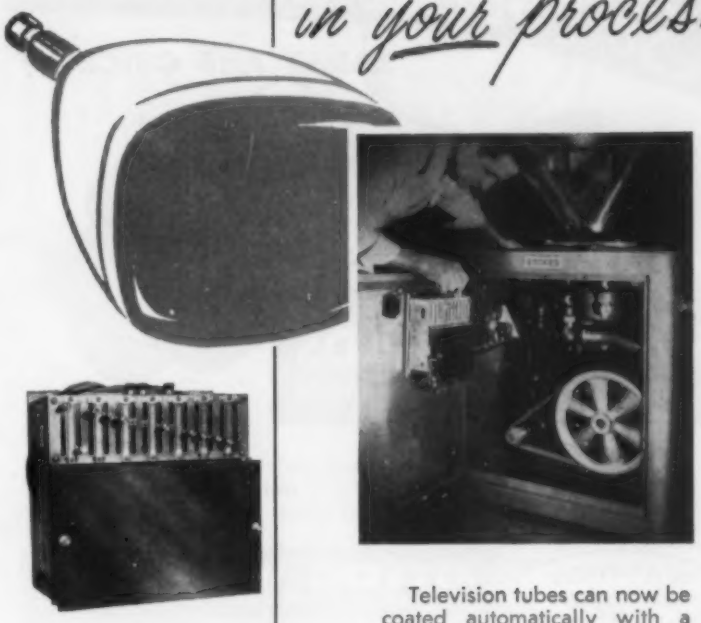
A comprehensive and practical treatment of the most important noise problems in electronic devices, this book reduces noise problems to an analysis of simple networks.

The first ten chapters are devoted to network or vacuum tube electronic problems which can be solved by standard methods. Specific chapters are included on noise figures, noise ratios and low-circuit noise, as well as a section on transistors, plus new material on the influence of feedback noise.

The organization of the book makes it possible to read all of the "practical" material (Chapters 1-10, 16) independently of the "theoretical" material (Chapters 11-15). For those who wish to study both simultaneously, cross-references are given.

Chapters 11-15 discuss those noise problems which demand a more elaborate mathematical treatment than is required in the first part of the book. Chapter 11 deals with the laws of probability, statistics, and thermodynamics which are needed for problems in noise. Chapter 12 deals with the Fourier analysis of fluctuating quantities. Response of detector circuits to noise is treated in Chapter 13, and the laws of vacuum tube electronics

Let EAGLE put profit in your process



Television tubes can now be coated automatically with a new metallizing unit developed by F. J. Stokes Machine Co. All operations—closing and opening of valves,—starting and stopping of vacuum pumps,—on and off of vaporizing current,—all are controlled by one Eagle Multiflex Timer. Let Eagle timers speed up production, increase quality, and reduce rejects for greater profit for you. Eagle builds a timer for every timing problem.

Automation STARTS WITH EAGLE Timers FOR ANY SIZE INDUSTRY

Send for FREE Automation Booklet "See what timing can do for you?"

Industrial Timers by EAGLE

EAGLE SIGNAL CORPORATION MOLINE, ILL.

NOW CONVERT YOUR STEEL HAMMER TO A

Soft Faced HAMMER

EASILY AND QUICKLY!

WALDEN

HAMMERHEADS

with COPPER, LEAD or PLASTIC INSERTS

PATENT NOS. 2515143 AND 2499802
OTHER PATS. PEND.

Strong steel cup with a soft metal or plastic insert which can be quickly fitted to your present hammer and held firmly in place by taut steel coil-spring as shown.

Write for catalogue

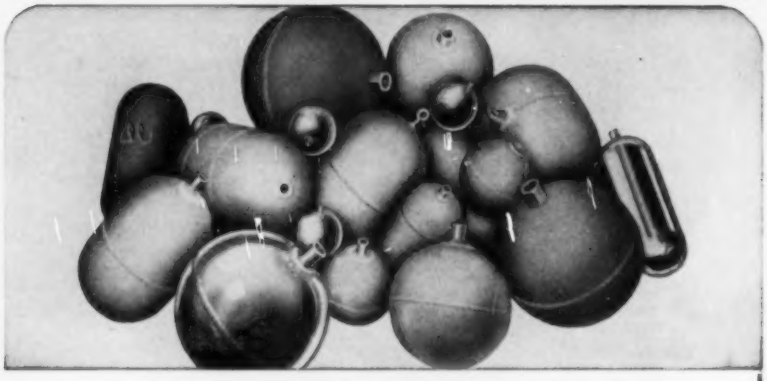
WALDEN TOOLS

STEVENS WALDEN Inc.

461 SHREWSBURY STREET — WORCESTER, MASSACHUSETTS

MAKERS OF WORLD-FAMOUS HAND TOOLS FOR OVER 50 YEARS

P-102



Send for Nicholson

FLOAT BULLETIN 753

Complete Data on Welded Floats; Diagrams, Tables, Formulae for Calculating Buoyancies

The booklet is a standard reference for specifiers of welded floats. Nicholson furnishes any type for external or internal pressures; in stainless steel, Monel, chromium, cadmium or copper-plated steel. Sizes, 2" to 14" diam., press. to 4250 lbs.; standard or special connections. Quick delivery on many sizes and shapes. Nicholson floats are standard with hundreds of manufacturers.

W. H. NICHOLSON & CO.

TRAPS · VALVES · FLOATS

200 Oregon Street, Wilkes-Barre, Pa.

and electron wave tubes are considered in Chapters 14 and 15 respectively. A discussion of noise in physical measurements appears in Chapter 16.

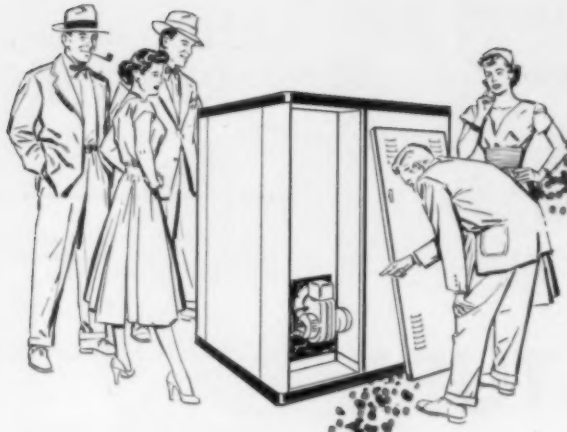
The nomenclature and measurement methods used in Chapter 3 of this book agree closely with recommendations of the Institute of Radio Engineers given in its "Standards on Electron Devices: Methods of Measuring Noise." (Proc. Inst. Radio Engrs., Vol. 41,890, 1953.)

Airplane Structures, Vol. I

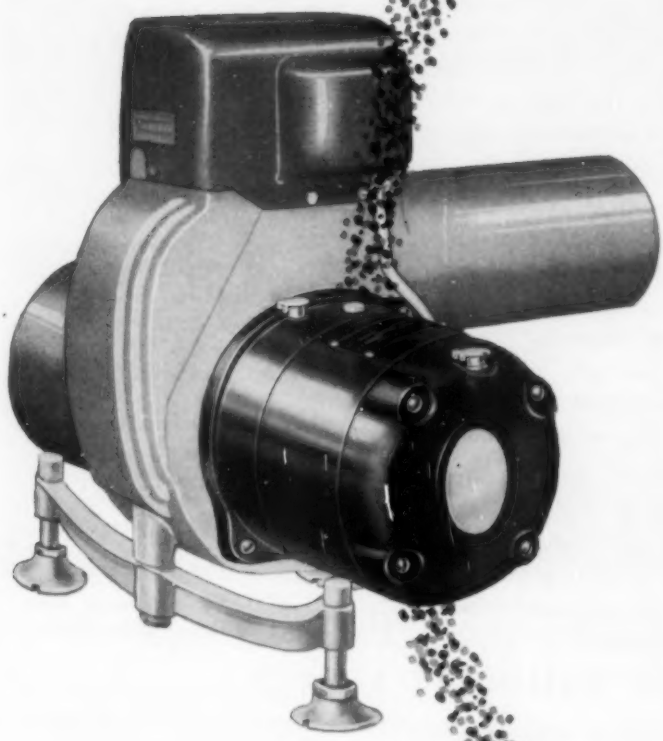
ALFRED S. NILES, *Professor of Aeronautical Engrg., Stanford University, and* JOSEPH S. NEWELL, SR., *Late Professor of Aeronautical Structural Engrg., M.I.T.* 6½ x 9 *in.*, 607 *pp. Published by John Wiley & Sons, Inc., 440 Fourth Ave., New York* 16, *N. Y.*, $7.75.

The effective application of the principles of stress analysis remains the primary objective of this fourth edition. A study of the general theory of structures, the book emphasizes methods appropriate to the analysis of structures in which high strength/weight ratios are essential. Procedures have been selected on the basis of their importance to aeronautical engineers.

Perhaps the most important change in the new edition is the increased emphasis on thin metal construction, through improved coverage of incomplete-tension field and constant-shear-flow webs, patterns of internal stress distribution, combined bending and torsion of shells, plate buckling, and local instability failures. Besides this, an entirely new chapter has been added on the physical properties of structural materials. Promising methods for the analysis of lap joints, based on recent research at the Massachusetts Institute of Technology, now appear in the chapter on connections. Formerly in the second volume, the exposition of the basic Maxwell-Mohr method for the analysis of statically indeterminate structures has been revised and included here. These and other changes are introduced at the volume's customary level, one which stands between elementary books on strength of materials, and advanced treatises on theories of structure, elasticity and plasticity.



it keeps the home fires burning!



Oil heat — automatic, dependable, economical — is a symbol of comfortable living in homes everywhere.

Many of America's best known oil burner manufacturers depend upon Emerson-Electric motors to keep their units operating efficiently.

Emerson-Electric builds motors for specialized applications such as oil burners, and for all types of equipment where dependability and long life are of first importance. It has done so for 64 years, and offers standard motors in ratings from 1/20 to 5 h.p., and hermetic motors 1/8 to 20 h.p. Your inquiry is invited.

THE EMERSON ELECTRIC MFG. CO.
St. Louis 21, Mo.

Write for these Emerson-Electric Motor Data Bulletins

Manufacturers requiring motors 1/20 to 5 h.p. can profitably use these reference guides. Specifications, construction and performance data are included for these motors:

- ☐ M445-A Capacitor-Start
- ☐ M445-B Split-Phase
- ☐ M445-C Integral
- ☐ M445-D Fan-Duty
- ☐ M445-E Oil-Burner
- ☐ M445-F Jet Pump
- ☐ M445-G Blower

EMERSON ELECTRIC
MOTORS • FANS APPLIANCES

When the pressure's on

your best bet is

FLEX-O-TUBE

If you use flexible hose in your product or for replacement in your plant, it will pay you to specify Flex-O-Tube. For here is a name that has stood for finest quality and dependable service for more than a quarter of a century.

In the development of new uses for flexible hose, Flex-O-Tube provides you with dependable experience in the field. When used for replacement in industrial maintenance, Flex-O-Tube provides you with a complete range of products that are easy to assemble and long on performance.

Whatever your needs, why not discuss them with the local Flex-O-Tube field engineer. You'll find there are many good reasons why industry has relied on Flex-O-Tube for miles and miles of flexible hose products.

Supplied in Assemblies

Flex-O-Tube will help you determine the assembly needed or work to your own specifications. In either case, modern facilities and latest inspection techniques assure you a uniformly high quality product delivered promptly.

Supplied for Field Assembly

Flex-O-Tube hose is also supplied in bulk coils with reusable fittings for field assembly. Complete range of sizes and types.

Please send me your free ☐ aircraft catalog. ☐ industrial catalog.

Name .....

Company .....

City ..... Zone ..... State .....

Address .....

FLEX-O-TUBE

DIVISION OF MERIDAN CORP.

2531 JIM DALY ROAD • INKSTER, MICHIGAN

Flex-O-Tube Co. (Canada), Ltd., Windsor, Ontario

OUR READERS SAY

Letters should be addressed to The Editor, *Product Engineering*, 330 West 42nd St., New York 36, N. Y.

Another Need for Standards

To the Editor:

Referring to your editorial "Standards Without Worth," in *Product Engineering*, June 1954, let's hope your cry in the dark for sensible size designations will start the pendulum swinging. American users of sheet products, to pick the most vulnerable situation, have only themselves to blame for the present condition.

In a future editorial, how about plugging American Standards Z17.1-1946 "Preferred Numbers" and B32.1-1952 "Preferred Thicknesses for Uncoated Thin Flat Metals (Under 0.250 in.)? These standards, developed by representatives of American industry, are based on a logical mathematical basis for progression in sizes or thickness.

The U.S. Naval Ordnance Plant, Indianapolis, has for a number of years had standards prohibiting the use of gage numbers for sheet materials and restricting the use of gage numbers in other type products.

—THOMAS T. HAVER
U. S. Naval Ordnance Plant
Indianapolis, Indiana

Ed—Mr. Haver's suggestion that in a future editorial we plug the American Standards Preferred Numbers and Preferred Thicknesses for Uncoated Thin Flat Metals is an excellent one. We are going to do just that. Beginning with the September number, we are going to plug very strongly for a sensible basis for the designation of sheet thicknesses, screw diameters and the like.

I had the Preferred Numbers in mind in the June number in writing . . . "it would be more logical to use a mathematical basis for the progression in thicknesses or diameters." I did not want to get any more specific than that because I only want to hammer away at one item in an editorial. This

Recommends Materials Best Adapted to your Vibration Control Requirements

Metal—Natural Rubber—Silicone—Neoprene—Buna S—Buna N—and others are selected by LORD Engineers to satisfy your specific environmental conditions and assure the most economical solution of your vibration control problem.

LORD research is constantly developing and evaluating new materials and processes to insure that the most complete line of vibration control mountings is at your disposal.

LOS ANGELES 28, CALIFORNIA	DALLAS, TEXAS	PHILADELPHIA 7, PENNSYLVANIA	DAYTON 2, OHIO
7046 Hollywood Blvd.	313 Fidelity Union Life Building	725 Widener Building	410 West First Street
DETROIT 2, MICHIGAN	**NEW YORK 16, NEW YORK**	**CHICAGO 11, ILLINOIS**	**CLEVELAND 15, OHIO**
311 Curtis Building	280 Madison Avenue	520 N. Michigan Ave.	811 Hanna Building

LORD MANUFACTURING COMPANY • ERIE, PA.

Over 27,000 basic designs and their variations are already available from which to choose.

LORD — BONDED RUBBER

Headquarters for **VIBRATION CONTROL**

Impossible?!—Not for Tubular Rivet
problem
Set a rivet in an "impossible" position, fastening two aluminum extrusions. Usual high production requirements. Obstructions: ¼" below clinch, ⅛" from side wall, ⅛" from back wall.
solution
Special solid anvil form on offset holder applied to TUBULAR'S automatic riveting machine. Form locates workpieces and rivet is "shot blind" i.e. without positioning work on conventional spring pin anvil.
P.S. Customer has since found another application (formerly "impossible") for this machine. If you have an inaccessible fastening location let us see if we can solve it by production riveting on one of our riveting machines. Forward prints or samples to TUBULAR RIVET, Dept. PE.
Tubular Rivet
& STUD COMPANY
WOLLASTON 70, MASSACHUSETTS
BRANCH OFFICES: Buffalo, Chicago, Dallas, Detroit, Indianapolis, Los Angeles, Nashville, New York City, Philadelphia, San Francisco, St. Louis

first editorial was to get rid of the number designation. The logical next step is to establish logical designations for thicknesses or diameter wherever such is feasible.

To the Editor:

In leafing through the current issue of *Product Engineering,* I noticed a reference in your "Sans Souci" column to "a little story in some popular magazine or other."

You may be interested to know that the story you paraphrase is a Chinese copy of an original called "The Verger," by W. Somerset Maugham. Whoever copied it in the magazine you read, changed the mercantile details of the story, as well as the name of the chief character, but, curiously enough, adhered to the sexton angle while pulling in a very awkward reason (the inability to write notes) to justify the firing from the church.

Since you start your last paragraph with "Decades Later," I assume that you ran into the story decades ago. If this is the case, perhaps Maugham is the culprit!

—RICHARD L. LEE
Westinghouse Electric Corp.

Ed—Mr. Lee is correct in that I read the story in about 1925 in the *Ladies' Home Journal,* I believe. I was not a regular reader of that publication; my good wife called my attention to the story.

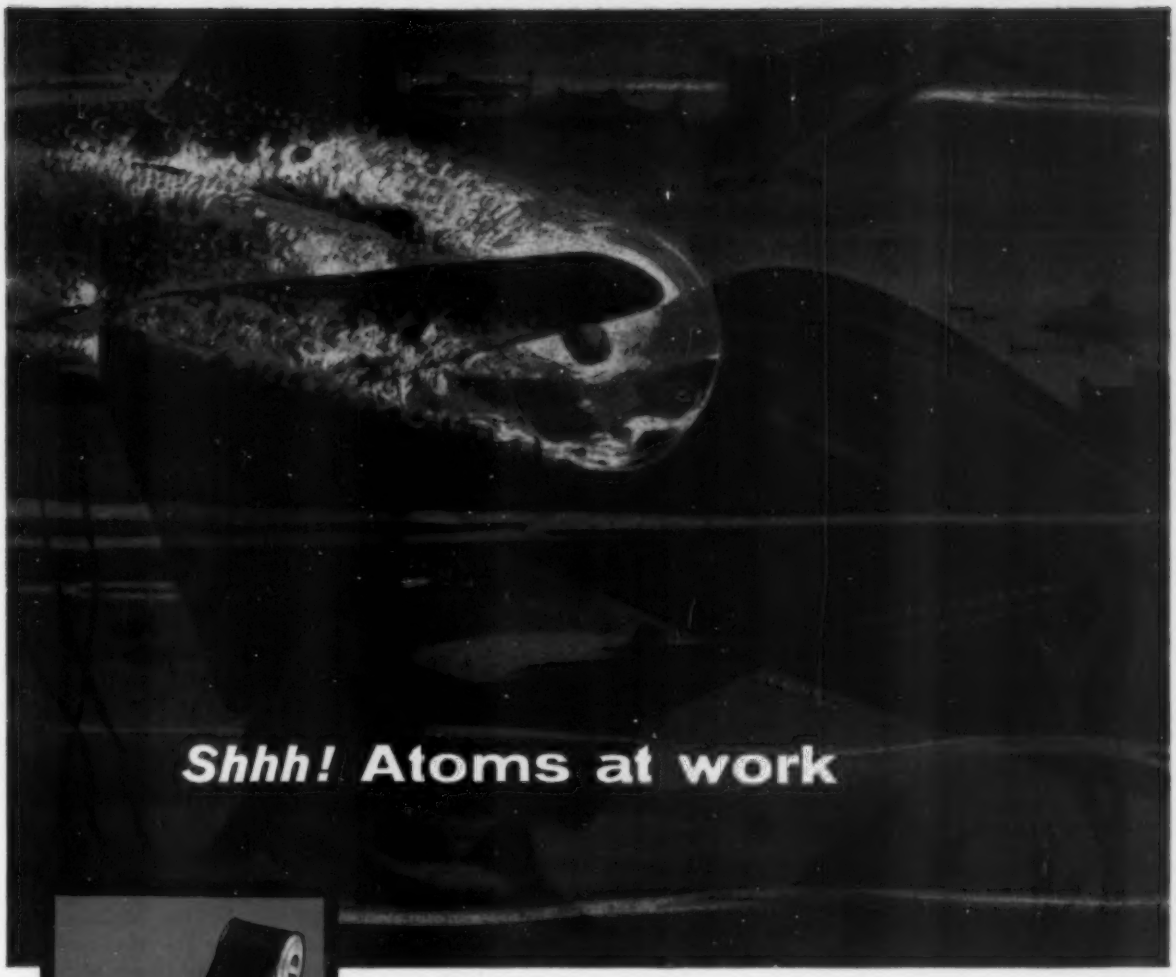
Inter-Industry, International Agreement

To the Editor:

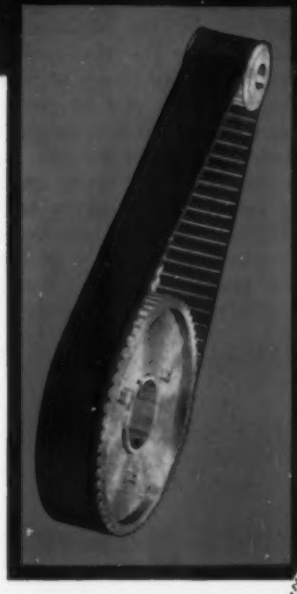
I have just read your article "Should Current Drafting Practices be Further Simplified," and find that in general it agrees very closely with my own thinking and with our practices here at Pratt & Whitney Aircraft.

There is one sentence which troubled me a bit however. It is the one near the top of the righthand column on the last page; it reads, "To date, this committee has made considerable progress in bringing the drafting practices of not only the two industries into agreement, but also those of Britain and Canada."

This sentence seems to say that we have helped bring about two reconciliations; one between the aeronautical and the aircraft groups, and another between the British and Canadian groups.



Shhh! Atoms at work



NOT ONLY is the U.S.S. Nautilus the first submarine to be propelled by atomic power! She is also by far the most silent in operation . . . and therefore most difficult to locate by enemy sound-detecting devices and acoustic torpedoes.

To match the uncanny silence of her nuclear-generated-steam turbines, her builders* have wisely employed Gilmer "TIMING" BELTS for certain drives. Since it is the only type of drive that can transmit power at a constant angular velocity *without metal-to-metal contact*, the "TIMING" BELT was a "natural" for tachometer drives and various control drives requiring non-slip operation or accurate calibration.

*ELECTRIC BOAT DIVISION
OF GENERAL DYNAMICS CORPORATION

Security considerations naturally prohibit further elaboration or illustration. We are gratified, however, that this *newest form of power transmission* was chosen by some of the world's best engineering brains to fill a specific need in this first practical application of man's *newest source of power*.

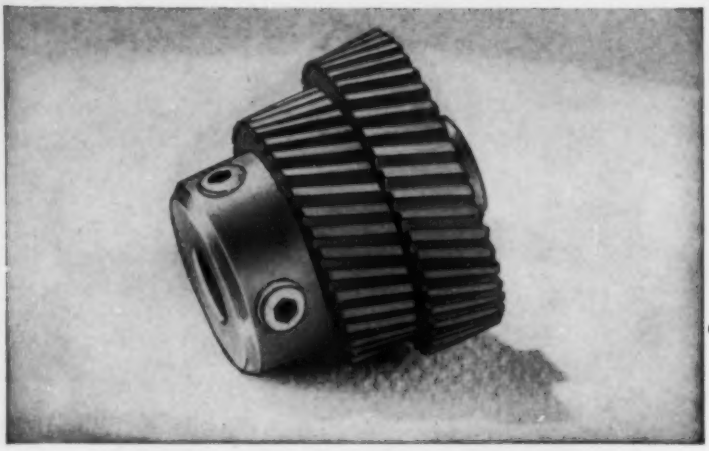
In industry there are already more than a million of these unique tooth-grip belt drives in operation, providing quiet, positive transmission of from $\frac{1}{100}$ to 300 horsepower . . . with practically 100% efficiency . . . at speeds up to 15,000 fpm . . . and without need for lubrication, adjustment or other servicing. Write us for your copy of the Gilmer "Timing" Belt Drive Manual.

THE *Gilmer* "TIMING®" BELT DRIVE
for positive POWER TRANSMISSION at its best
is a product of

NYB&P — NEW YORK BELTING & PACKING CO. — Founded 1846

NEW YORK BELTING & PACKING CO. 1 Market St., Passaic, N. J.

America's Oldest Manufacturer of Industrial Rubber Products



NYLON GEARS

CAN SAVE YOU UP TO 90% ON GEAR COSTS . . . . .

- QUIET
- DURABLE
- EFFICIENT
- NEED LESS OR NO LUBRICATION

FOR over a decade we have been manufacturers of fine pitch gears. In this we are serving some of America's most particular users of precision and commercial gearing.

Now we have added a completely equipped department for producing Nylon Gears. Because of our past experience and our facilities, we are a logical source for Nylon gears. We can mold large quantities at savings up to 90%. We can cut smaller quantities from molded blanks at definite savings. We can produce experimental work cut from Nylon bars.

A Nylon Gear can mate with a metal gear —we can make both—and be responsible for the performance of both. Benefit by our KNOW HOW to SHOW HOW Nylon Gears can be adapted to your use.

When you think of GEARS . . . in any material . . . think of GEAR MEN

P&G

PROCESS GEAR CO., INC.

4616 WEST FULLERTON AVE., CHICAGO 19, ILLINOIS

I believe what you had intended, might be more nearly conveyed by the following: "To date, this committee has made considerable progress in bringing the drafting practices of not only the two industries into agreement, but the resulting recommended practices more nearly agree with those of Britain and Canada, in several respects."

I mention this simply with the thought that Canadian and British readers may question this item and that you may care to review it prior to any possible future printing.

It's a darn good article!

—JOSEPH STANNARD
Member SAE Aero-Auto Drafting Subcommittee

You are so right. The statement which you made concerning the drafting practices which we are trying to reconcile is much more accurate than the one I made in the article. I am certainly glad that you have pointed this out.

—J. GERARDI

Assistance Please

To the Editor:

I am currently editing "Handbook of Noise Reduction Engineering" to be published by the McGraw-Hill Book Company. The Handbook is intended to cover all phases of noise, its effects on man, and its control. Since special emphasis is being placed on noise problems in industry and their solutions, I would appreciate receiving suitable data from industrial firms who have conducted noise studies in their plant or made noise analyses of their products, either in various stages of design or in production testing.

—PROFESSOR CYRIL M. HARRIS
Columbia University

The Simplified Drafting Controversy Continues

From the Author:

Following are the comments which I have received to date stemming from my article "Should Current Drafting Practices be Further Simplified," *Product Engineering*, May 1954. The most important of these is a letter dated June 7 from Mr. Joseph Stannard, a member of our Joint SAE Drafting Committee.

Although I have sent out 400 re-

New time-saving AMF Everlock pre-assembled screws and lockwashers. In types, sizes and materials to meet your needs.

fasten it and forget it...

Specify Another AMF Product

Everlock
INDUSTRIAL FASTENERS

Tight, vibration-proof fastenings—*for the life of your product.*

New AMF Everlock pre-assembled screws and lockwashers give you both . . . fast, one-operation application and vibration-proof tightness. Everlock washers, with the exclusive alternating chisel edges, actually bite into the surface of both screw and part. Even under the most punishing vibration, Everlock fasteners stay secure—for *good!*

Everlock locknuts spin down finger-free. After contact with work only ¼ turn gives a sure, permanent 6-way lock. Combine unequalled speed of application with true vibration-proof performance.

On your next order for fasteners, specify AMF Everlock—and *fasten it and forget it.* Sizes, types and materials to meet any specifications.

Write for information or contact your nearest AMF Everlock Representative.

Kenneth D. DeLanoy
Dayton 3, Ohio

Oscar P. Martin
Lakewood 7, Ohio

J. Ramsey Reese, Inc.
New York 7, New York

J. M. Murphy
Manchester, Connecticut

Russell T. Brosius
Philadelphia 3, Pa.

Sam T. Keller
Detroit 1, Michigan

W. L. Barth, Jr.
Chicago 34, Illinois

C. W. McNeil
Houston, Texas

Leonard F. Berg
St. Paul 14, Minnesota

Thom Lundeen
Moline, Illinois

Forrest Maschner
St. Louis, Missouri

A. J. Murphy
DeWitt, New York

Richard C. Dudek
Beverly Hills, California

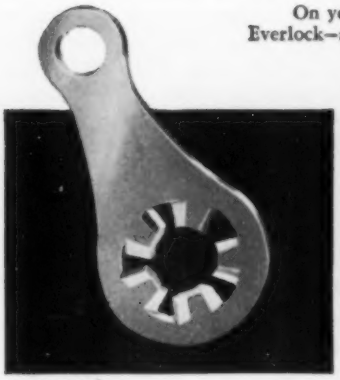
P. L. Robertson
Milton, Ontario, Canada

Sam T. Gleaves
Louisville 5, Kentucky

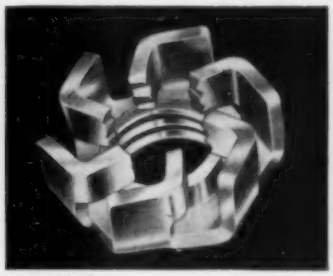
J. J. McIntosh
Atlanta 6, Georgia

Donald G. Teeling
Indianapolis 44, Ind.

Oregon Indus. Factors
Portland 1, Oregon



TERMINALS
Plain and lock types.



LOCKNUTS
Both National fine and National coarse threads.

LOCKWASHERS
Internal, external and special types.

THOMPSON-BREMER & COMPANY
520 North Dearborn Street • Chicago 10, Illinois
SUBSIDIARY OF AMERICAN MACHINE & FOUNDRY CO., NEW YORK

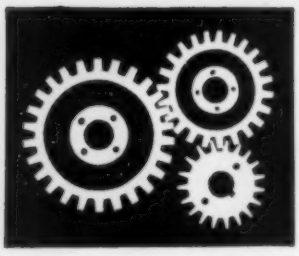
"EVERLOCK" IS A REGISTERED TRADEMARK OF THOMPSON-BREMER & COMPANY

From huge aircraft engines to tiny precision instruments—there's no end to the variety of products improved by Perkins custom-cut Gears!

Perkins is a *gear engineering* organization with a 35 years' tradition of New England craftsmanship as background. As one of the country's largest producers of gears to customers specifications, Perkins will meet your specific requirements for gears—regardless of size, type, material or quantity desired, *and at competitive prices*. You furnish the specifications, we'll produce the gears.

PERKINS MAKES in all materials, metallic or non-metallic, and in any size, to your specifications: helical gears, bevel gears, sprockets, ratchets, worm gears, spur gears with shaved or ground teeth, ground thread worms.

NOTE: The **PERKINS PRECISION SPRING COILER** is the latest development in the spring coiler field and eliminates entirely the use of arbors and long set-up time. It is a complete self-sufficient machine and enables you to make the spring you want *when* you want it — in seconds. The coiler produces any type of spring, in any diameter and any pitch with this range: Wire Sizes .005 to .125. Diameter from 3/32" to 12" and larger. Size of the compact coiler is only 7½ x 16". **A POWER MODEL** mounted on a welded steel console cabinet base is also available. Full information on request.



Perkins Machine & Gear Company

WEST SPRINGFIELD, MASS.

prints of the article, most of them were sent to professors at different colleges throughout the United States. Unfortunately, most of these men at the present time are on vacation, and I expect that we would have had more comments had the reprint been sent earlier.

You would also be interested to know that several of my friends told me that the subject of simplified drafting came up at the annual meeting of the Drawing Division of ASEE. I was unable to attend the meetings, though I heard that several of the speakers referred to the article and that everyone was advised to read it if they hadn't received a copy.

—J. GERARDI
Asst. Dean
University of Detroit

Broad Application Not Practical

To the Editor:

I cannot help but admire your restraint. I feel that your type of presentation is probably more effective than an aggressive or somewhat belligerent presentation of the advantages of a not too simplified standard of drawing.

We feel that this extremely simplified drawing might be all right among close friends or within a small group or for an engineer to give his draftsmen, but certainly it must have a great many disadvantages when the distribution is broader.

It has been pointed out to me by local industrial leaders that "shop time" is so expensive these days that more often than not, any saving in the drafting room is offset by a greater loss of time by one or more men in the shop and, therefore, no real saving occurs.

—HAROLD SKAMSER
Professor of Engrg. Drawing
Michigan State College

New Drafting Techniques?

To the Editor:

In response to the question about a year ago when Healy and Rau first came out, I think it was to you—perhaps to Aakhus or Northrup—that I criticized their discovering drafting techniques I used on the design board forty years ago. I would have been fired if I had not cut corners within the limits of common sense clarity. As I remember, too, I added—relative to their questionable drafting, 90 deg

A-MP FIRST IN SWITCHGEAR!

NEW DYNA-CRIMP TOOL
New, powerful, DYNA-CRIMP tool features fast positive crimping action and easily-opened swivel head. Crimping heads can be changed easily. A-MP DYNA-CRIMP tool gives maximum portability with remote control operation. Interchangeable dies are available for use with A-MP's complete line of Aluminum and Flag terminals. Shown above with moveable cart to transport power unit providing maximum flexibility for Bench-Production line use.

BONDING FEATURE MOST IMPORTANT
Bonded insulation is the most important factor *in producing a successful insulated terminal.* The positive and complete bond of the insulation to the terminal sleeve insures uniform insulation thickness under crimping pressures, and therefore transmits this pressure evenly to the center of the crimp area. With this precision-engineered A-MP crimp and BONDED insulation you can be sure of maintaining proper dielectric and tensile values in the finished connection. More intimate contact achieved by confining, over a greater area, terminal and wire under intense crimping pressure.

SIZES 8 THROUGH 4/0

Ampli-Bond
Trade-Mark

THE ONLY LARGE SIZE TERMINAL WITH BONDED INSULATION!

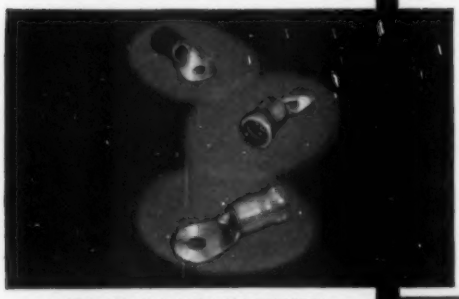
WITH INSULATION SUPPORT AND SUPERIOR A-MP CONFINED CRIMP.

10 distinctive and distinguishable features make precision-engineered AMPLI-BOND terminals the best quality insulated termination for copper wire.

- INSULATION WITHSTANDS A MINIMUM OF 6000 VOLTS!
- INNER COPPER SLEEVE FOR STRENGTH AND VIBRATION RESISTANCE
- FULLY INSULATED METALLIC REINFORCING RING GRIPS INSULATION
- COLOR CODED FOR RAPID IDENTIFICATION
- BRAZED BARREL SEAM
- SUPERIOR A-MP CONFINED CRIMP
- INNER BARREL DIMPLED FOR INCREASED TENSILE STRENGTH
- COPPER TERMINAL BODY ELECTRO-TINNED FOR HIGH CONDUCTIVITY
- BONDED INSULATION
- PROOFMARK FOR POSITIVE IDENTIFICATION

Here is a large size terminal that presents to the users of heavy duty wire the same quality connection that has made A-MP famous for PRE-INSULATED type terminals throughout the industry. Write today for information about AMPLI-BOND and new powerful AMP DYNA-CRIMP portable pneumatic-hydraulic crimping tool.

AMP Trade-Mark Reg. U.S. Pat. Off. © AMP



OTHER IMPORTANT A-MP "FIRSTS"
Completely separate metallic reinforcing ring grips wire insulation, prevents exposure of conductor during sharp bends, cable fatigue caused by flexing and vibration and forms a barrier to foreign objects coming in contact with current carrying members. New helical tongue design gives maximum strength with minimum weight.

Find out about the New AMP "CREATIVE APPROACH TO BETTER WIRING"

An evaluation survey without cost or obligation.

Aircraft-Marine Products, Inc.
2100 Paxton Street, Harrisburg, Pennsylvania

In Canada . . . . Aircraft-Marine Products of Canada, Ltd.
1764 Avenue Road, Toronto 12, Ontario, Canada

Your source for 2K50

REFLEX KLYSTRON TUBES

The new Bendix Red Bank 2K50 is the perfect answer for those who want a thermally-tuned Reflex Klystron tube for K-band operation.

The 2K50 has two primary applications—first, as a local oscillator in small, compact, lightweight, high definition radar and, second, as an oscillator in microwave spectrometers, signal generators and spectrum analyzers.

Because of its thermal feature, the 2K50 may be tuned automatically. Thus, it is ideally suited for difficult locations . . . in aircraft, for example . . . where direct or mechanical tuning is not practical.

Perfection of the complex, ultra-precision 2K50 . . . one of the most difficult electron tubes to manufacture . . . is a tribute to the unique talents of our engineers and production men. It demonstrates why you can depend on Bendix Red Bank for the answer to *any* special-purpose electron tube problem you may have.

MAXIMUM RATINGS

Resonator Voltage	330 volts D.C.
Reflector Voltage	−150 volts D.C.
Tuner Grid Voltage	−50 volts D.C.
Filament Voltage	6.3 ± 8% volts
Gun Cathode Current	28 ma. D.C.
Tuner Cathode Current	10 ma. D.C.

ELECTRICAL CHARACTERISTICS

Heater Voltage (A.C. or D.C.)	6.3 volts
Heater Current	.755 amps.
Thermal Tuning Range	23216 to 24751 Mc/Sec.
Min. Power Output at 23504 Mc/Sec.	8.5 mW.
Min. Power Output at 23984 Mc/Sec.	10.0 mW.
Min. Power Output at 24464 Mc/Sec.	8.5 mW.
Min. Electronic Tuning at Mid-Band	55 Mc/Sec.

PHYSICAL CHARACTERISTICS

• Dimensions: Maximum seated height 2¼" • Base: Small Octal 8-Pin, B8-21, Low Loss Phenolic Wafer • Coupling to Wave Guide: Direct, by means of an insulating fitting • Cooling: Convection • Mounting Position: Any • Cavity: Silver Plated Steel (integral within the bulb) • Bulb: Metal • Output Window: Low loss glass

Bendix Red Bank

Manufacturers of Special-Purpose Electron Tubes, Inverters, Dynamotors and Fractional HP D.C. Motors

DIVISION OF

THE NAME Bendix AVIATION CORPORATION MILLIONS TRUST

EATONTOWN, N. J.

West Coast Sales and Service: 117 E. Providencia, Burbank, Calif.
Export Sales: Bendix International Division, 205 E. 42nd St., New York 17, N. Y.
Canadian Distributor: Aviation Electric Ltd., P.O. Box 6102, Montreal, P.Q.

points on drills, etc., etc., that they were doubtless charming gentlemen and good electricians, but that their contribution to the literature of the field was little more than a rationalization of their own incompetence.

—JOHN M. RUSS, HEAD
Dept of Engrg. Drawing
State University of Iowa

Simplified ("Mystified") Drafting

To the Editor:

I have just received and read your article in *Product Engineering* concerning "simplified" (or is it "mystified?") drafting. This is something that has needed saying, and I am happy that you have had the courage to say it in very plain meaningful language.

—H. C. SPENCER, DIR.
Technical Drawing Dept.
Illinois Institute of Technology

Spoilage Condoned

To the Editor:

Your article "Should Current Drafting Practices be Further Simplified," in *Product Engineering*, gets to the heart of most of the practices recommended by Messrs. Healy and Rau.

Not only have I read their book, but I also worked in the same drafting department fourteen years ago. They can justify their position because all spoilage including that due to misreading drawings is recorded. So long as the spoilage does not increase above a predetermined percentage of total production, the policy is acceptable.

Finally, like many large companies, they boast of the longevity of their employees, which means that it is habit as much as simplified drafting that makes these practices possible.

Personally, I am all for your suggestions that drafting standards be studied with a view to industry-wide use.

—MARVIN O. YOUNG
All American Engineering Co.

CORRECTION

On page 224 of the August 1954, *Product Engineering*, an incorrect address was given for the C. A. Norgren Co., makers of a Spray coolant system. The correct address: 3428 S. Elati, Englewood, Colorado.

"We save 2 ways with WEBSTER PUMPS"

says Service Caster & Truck Corporation

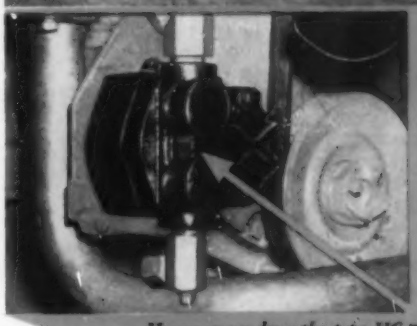
"The WEBSTER Hydraulic Pump has been very satisfactory. It is easy to install because the drive gear is an integral part of the pump drive shaft. This is an economy feature; we save time installing the unit, and eliminate the problems of a keyed assembly.

"Another reason we use the WEBSTER pump is that it is lower priced than most of the others available for this particular installation. It helps us get the contract.

"This WEBSTER Hydraulic Pump compares favorably with the pumps that we've used previously . . . and saves us money two ways."

From an interview with L. D. Hoffman, Chief Engineer, Service Caster & Truck Corporation, Albion, Michigan recorded by a WEBSTER EKOTAPE

S4024 4000-lb. fork lift truck, made to U. S. Navy specifications for the Army by Service Caster & Truck Corp., is equipped with a WEBSTER Hydraulic Pump



Here you see how the type HC WEBSTER pump is attached for direct drive from engine of Service Caster-built fork lift truck

Choose from WEBSTER'S 90 types

The type HC WEBSTER Hydraulic Pump used by Service Caster is but one of 90 types of positive displacement gear pumps with capacities from ⅙ gpm to 30 gpm—at pressures up to 1200 psi—speeds to 3600 rpm—with or without relief valves—for sealed or wet sump mounting.

One of these custom-built units may well be the answer to your particular application. They are highly adaptable to a wide variety of uses in oil hydraulic systems.

***Write** us today for a catalog which contains illustrations, descriptions, performance charts, and pump data sheets on which you can tell us your requirements.*

OIL HYDRAULICS DIVISION

WEBSTER ELECTRIC

RACINE, WISCONSIN

ESTABLISHED 1909

"Where Quality is a Responsibility and Fair Dealing an Obligation"

MANUFACTURERS OF A COMPLETE LINE OF OIL HYDRAULIC PUMPS

More than 20,000 VIKING PUMPS
IN THE LAST 25 YEARS
on Littleford Bros. Equipment

YOU, too, can be assured of top pumping performance. Follow the example of Littleford Bros., Inc., Cincinnati. They know what Viking pumps can really do after incorporating over 20,000 of them on their road construction and maintenance equipment. Service includes handling hot or cold road oils, tars, asphalt, cutbacks and emulsions.

If you are looking for dependable pumps as original equipment, or for individual performance, follow Littleford's example and learn more about Vikings. Write for bulletin 54SX.

VIKING
AN HONORED NAME IN PUMPING

See Our Catalog in SWEETS

VIKING PUMP COMPANY
CEDAR FALLS, IOWA

STAINLESS fasteners
in STOCK

All types and sizes of screws (Phillips, slotted, hex head, socket), bolts, nuts, washers, rivets, keys and pins

- Over 9000 items in stock means *immediate delivery* from one source
- New Garden City plant now operating at top *speed and quality*
- Unsurpassed facilities for quantity fabrication of *specials*
- A staff of seasoned engineers always available for consultation
- Pioneers in the manufacture of stainless steel fasteners

WRITE NOW FOR FREE COPY OF FASTENER MANUAL P18

MANUFACTURERS SINCE 1929
ALLMETAL
SCREW PRODUCTS COMPANY, INC.
GARDEN CITY NEW YORK

Temperature Cycling Test Made Automatic

ARNOLD R. SHULMAN
Office of Naval Research
Special Devices Center
Port Washington, New York

MILITARY COMPONENTS and equipment must be capable of functioning reliably under a variety of conditions. The armed forces have determined that components should be capable of withstanding certain important environmental tests before being considered adequate for field service. One such important test is temperature cycling, required by most military component and equipment specifications. The partial list of these military specifications given in Table I indicates its importance.

The military standard MIL-STD-202, entitled, "Test Methods for Electronic and electric Component Parts", outlines the general test method to be followed in conducting a temperature cycling test. Table II summarizes the test procedure.

Specimens are subjected to one of the conditioning cycles in Table II, for a total of five cycles performed continuously. In transferring specimens from one chamber to another they are not to be subjected to cir-

Table I—Military Specifications Requiring Temperature Cycling Test

Specifications	Component
JAN-R-11	Resistor, fixed, composition
JAN-R-19	Resistor, variable, wirewound
JAN-R-29	Resistor, external, meter
JAN-R-94	Resistor, variable, composition
JAN-R-184	Resistor, fixed, wirewound
JAN-S-63	Switches, sensitive
JAN-J-641	Jacks, telephone
JAN-J-642	Plugs, telephone
MIL-T-27	Transformers
MIL-R-5757B	Relays, armature
BUSHIPS 16C38	Coils, radio frequency, choke
MIL-C-5A	Capacitors, fixed, mica
JAN-C-20A	Capacitors, fixed, ceramic-dielectric
MIL-C-11015A	Capacitors, fixed, ceramic (general purpose)

It's welded—
but you can't feel the weld

It has to be accurate

It's easy to fabricate

Specify Brainard FOR WELDED STEEL TUBING

• Brainard welded tubing is an economical structural material, and offers many physical advantages. It has a smooth exterior, with all weld flash removed. Its wall thickness is uniform, since it is formed from flat strip. With welded tubing you can cut weight without sacrificing strength. And there's practically no limit to the design requirements you can meet with this easily fabricated material.

Brainard maintains continuous quality control throughout manufacture—from ore to finished tubing. Careful supervision assures you high quality. For complete specifications call or write Brainard Steel Division, Dpt. GG-9 Griswold St., Warren, O.

Brainard

SHARONSTEEL

STEEL DIVISION
SHARON STEEL CORPORATION

precision parts of
TEFLON and KEL-F
Get the advantages of these fluorocarbon plastics at their best —fabricated by United States Gasket Company.
Quality controlled through every operation "from powder to part", they assure you uniform electrical, chemical and physical characteristics of the highest quality. Uniform density and dimensional stability permit superior accuracy and dependability in the finished part.
For all your requirements—sheets, tape, tubing, cylinders, rods, bars, beading, electrical spaghetti, extruded shapes, parts machined or molded to your specifications, and electro-mechanical assemblies and sub-assemblies—see U.S.G.
Write for bulletins No. 300 and No. 500.
UNITED STATES GASKET COMPANY
CAMDEN 1 • NEW JERSEY
FABRICATORS OF duPont TEFLON, Kellogg KEL-F AND OTHER PLASTICS
Representatives in Principal Cities Throughout the World

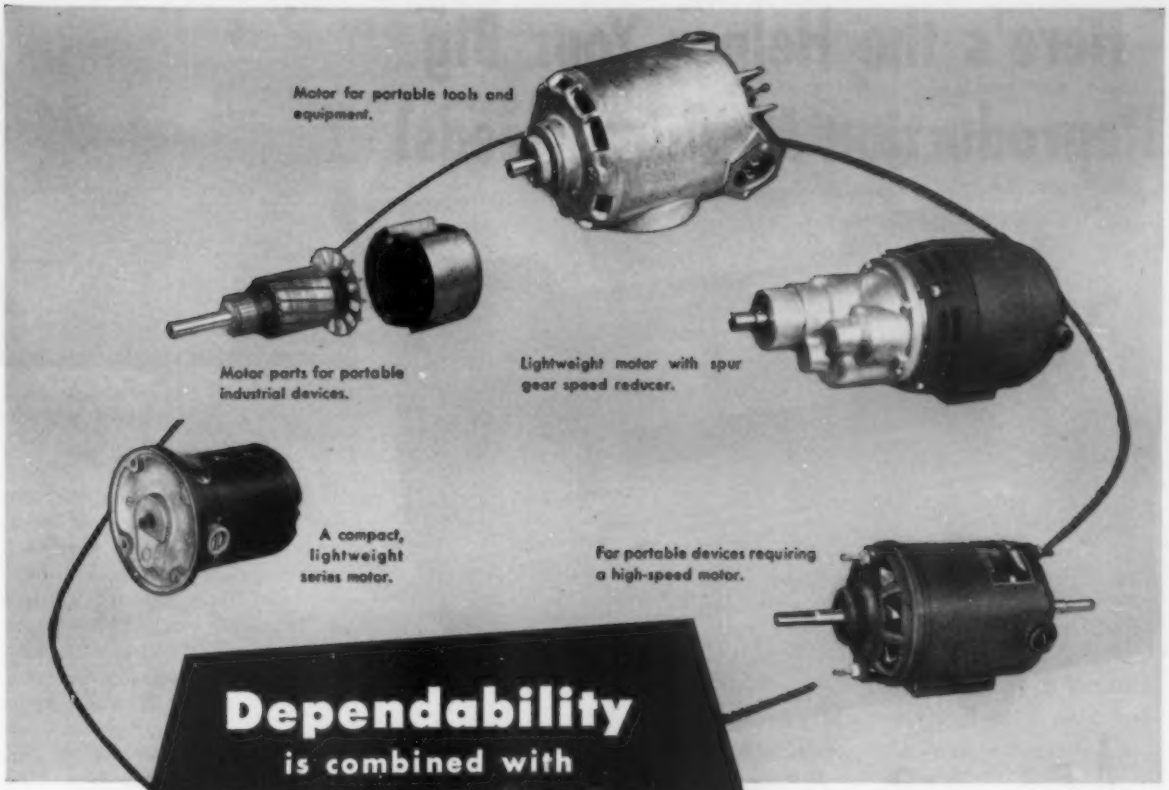
Table II

Condition A		
Steps	Temperature, °C	Time, min
1	85^{+3}_{-0}	30
2	25^{+10}_{-5}	10 to 15
3	-55^{+0}_{-3}	30
4	25^{+10}_{-5}	10 to 15
Condition B		
Steps	Temperature, °C	Time, min
1	65^{+3}_{-0}	30
2	25^{+10}_{-5}	10 to 15
3	-55^{+0}_{-3}	30
4	25^{+10}_{-5}	10 to 15

culating air. The capacity of the extreme temperature chambers should be sufficient so that the air at the specimens will reach temperature within two minutes after they have been transferred to the appropriate chamber.

The purchase of the temperature cycling test is to determine the resistance of a component to repeated thermal shocks of high and low temperatures. It is not necessary for the test specimens to reach thermal stability at the temperature of the test chamber during the short exposure time specified. Damage which might result from this test would normally consist of failure of terminals, seals, case seams, cracking of ceramics, and changes of the electrical or mechanical characteristics.

Measurements of such characteristics as these are made prior to the first cycle and one hour after the fifth cycle. The type of measurements taken, of course, depend on the type of component under test. The measurements to be made are generally not outlined. However, any damage which will impair its performance disqualifies the


Motor for portable tools and equipment.
Motor parts for portable industrial devices.
Lightweight motor with spur gear speed reducer.
A compact, lightweight series motor.
For portable devices requiring a high-speed motor.

Dependability is combined with Low Weight in...

★ Lamb Electric

SPECIAL APPLICATION FRACTIONAL HORSEPOWER **MOTORS**

THEY'RE POWERING AMERICA'S *Finest* PRODUCTS

The wide use of Lamb Electric Motors in aircraft components, home appliances, portable electric tools and other portable devices is impressive evidence of the fact that they combine thorough dependability with low weight.

To obtain these and the other advantages of Lamb Electric specially engineered motors, it is important that the motor be considered while the product is still in the design stage.

THE LAMB ELECTRIC COMPANY • KENT, OHIO

In Canada: Lamb Electric — Division of Sangamo Company Ltd. — Leaside, Ontario

Lamb Electric
SPECIAL APPLICATION FRACTIONAL HORSEPOWER MOTORS

Here's the Helper Your Big Reproduction Machine Needs!

Model 100 only $495.00

Specification Sheets, Check Prints and Engineering Changes Reproduced When You Want Them!

It just isn't common sense, is it, to tie up your big reproduction machine running pre-cut sheets? And now you don't have to. There's a new, economical unit that you can use for just this purpose.

The new Copyflex Model 100 has an 11-inch printing width. It operates up to 12 feet per minute and reproduces up to 300 copies in one short hour at a cost of less than 2¢ each.

Like all Bruning Copyflex machines, the Model 100 is clean, quiet and odorless . . . no ammonia or ozone vapors. No installation problems. It is so compact you can locate it anywhere and anyone can operate it.

If you are tying up your big reproduction machine running pre-cut sheets, let us show you how the new Copyflex Model 100 can save you time and money. Mail us the coupon below for full particulars of this new Copyflex.

BRUNING
Copyflex

Copies anything drawn, printed, written, or typed on ordinary translucent paper—in seconds.

Charles Bruning Company, Inc.
4700 Montrose Ave., Chicago 41, Ill., Dept. 314
Please send me more information about the Bruning Copyflex Model 100.

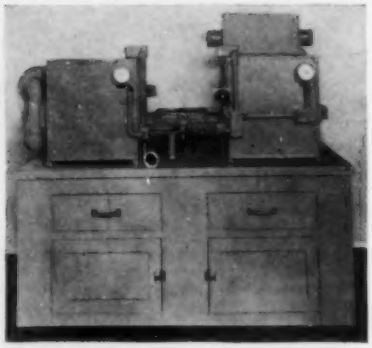
Name_____ Title_____

Company_____

Address_____

City_____ Zone____ State_____

CHARLES BRUNING COMPANY, INC. • 4700 MONTROSE AVE. • CHICAGO 41, ILL.



TEMPERATURE CYCLING unit developed at the New York Naval Shipyard's Material Laboratory

component. For example, telephone plugs and jacks are inspected to determine whether damages which will impair performance has resulted. Similarly, resistors are inspected for damage. A resistor which exhibits a permanent change in resistance in excess of a specified percentage (depending on resistor type and tolerance) would be disqualified.

A recent development of the Material Laboratory at the New York Naval Shipyard was the construction of a completely automatic temperature cycling apparatus. This equipment consists of a specimen tray which carries test samples from a hot to a cold chamber. The movement of the tray is accurately controlled by clocks which are preset to give the desired cycling.

This equipment is extremely versatile and can be adapted to accommodate almost any cycle. Table III illustrates the operational range of the equipment.

The thermostats controlling the temperatures of the chambers are easily and accurately set to any desired temperature. These thermostats are the

Table III—Operational Range of Test Equipment

	Portions of Cycle		
Temperature range	Hot Room temp. to 100 C	Cold Room temp. to −75 C	Room temperature
Accuracy	±1°C	±1°C	
Exposure time	1 min to 3 hr	1 min to 3 hr	1 min to 3 hr
Accuracy	Approx. 1 min	Approx. 1 min	Approx. 1 min

Here's modern press control at its ***SAFEST***

Yes, with the **Schrader Two-Hand Press Control** you'll find operator confidence soars—and so does production—because this easy-to-install unit can be operated only by both hands simultaneously. This means:

1 ***Production hits new highs*** **as operators, no longer worrying about personal safety, develop a new high-speed work rhythm in short order.**

2 ***Production stays high,*** **because the effortless fingertip operation with Schrader Controls leaves operators fresh and alert, even after a full day's work.**

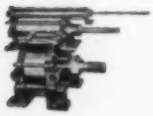
Look over the mechanical-clutch machines in your shop. Wherever you find operators straining back and leg muscles to maintain production—tiring themselves so that they are less alert to safety precautions—*there's a real need for Schrader Pneumatic Controls.* Available for easy foot operation as well as two-hand operation as shown here, Schrader Control Sets come complete and ready for mounting on your presses.

Ask us to help you decide which of the several Schrader Control Sets will fit your needs best. Simply write us, outlining your installation—or fill out the coupon below.

Schrader

REG. U. S. PAT. OFF.

Leaders in air control since 1844



A. Schrader's Son
Division of Scovill Manufacturing Company, Incorporated
477 Vanderbilt Avenue, Brooklyn 38, N. Y., Dept. U-1

I am interested in more information on _____

Name_____ Title_____

Company_____

Address_____

exclusive

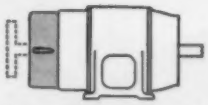
REULAND

"Xpandable" design

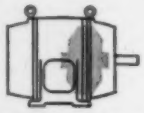
typical adaptations from this

BASIC DESIGN

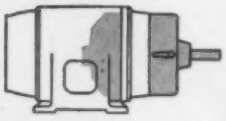
combines motors • brakes fluid couplings • gear-reducers into tailor-made single-unit POWER PACKAGES!



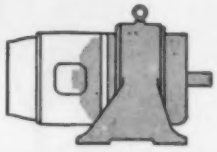
Motor with Reuland "Through Shaft" magnetic brake



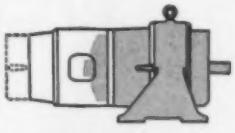
Motor with internal fluid coupling



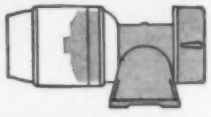
Motor with fluid coupling and brake on output shaft



Motor with fluid coupling and helical gear reducer



Motor with fluid coupling, output shaft brake and helical gear reducer (second brake may also be added)



Motor with fluid coupling, right-angle worm reducer and brake

GREATER COMPACTNESS...

one service responsibility!

Instead of buying and aligning several separate units, install Reuland *tailor-made, single-unit Power Packages.* You save space and weight, reduce prices up to 25% — simplify installation—improve in-the-field performance.

Literally dozens of combinations are available to fit every powering job. All economical, *standard assemblies* using the basic Reuland "XPANDABLE" motor design.

If your equipment utilizes a motor, brake, fluid coupling, gear reducer (or any combination) why not find out first-hand what a Reuland Power Package can do for you. Give us the details and we'll even submit a "tailor-made" test unit on approval.

OVER 800 "SPECIAL" ELECTRIC MOTOR DESIGNS...

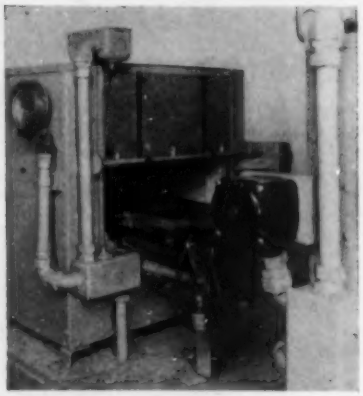
Still further versatility is provided by the Reuland "Library of Specials." Over 800 motors with special electrical and mechanical characteristics... 800 ways you can save development work, get in production faster!

Write today, outlining your particular power problem. No obligation, of course.

REULAND ELECTRIC COMPANY

Distributors in all principal cities

WESTERN DIVISION: Alhambra, California • EASTERN DIVISION: Howell, Michigan



SAMPLE TRAY automatically enters elevated temperature chamber

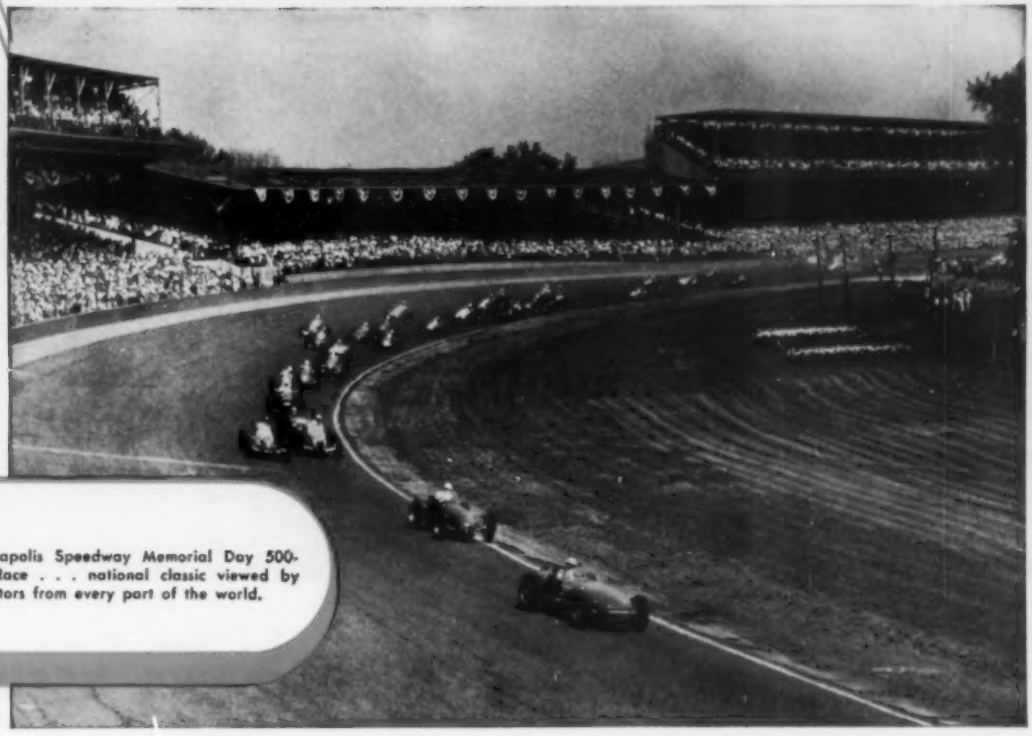
type which also indicate the actual temperature within the chamber. The cold chamber temperature is obtained by the use of dry ice. Special precautions were taken to eliminate the effect of frost on the operation of the equipment.

Before the use of the automatic equipment it was observed that variations in temperature and timing during the test often occurred. Personnel conducting this test were required to remain in attendance approximately 7.5 hr, plus one hour for measurements. This automatic temperature cycling equipment eliminates the human factor. No unwanted variations in timing, or temperature are possible. Personnel are now free to conduct other work at the same time that the temperature cycling test is being performed. The equipment automatically turns itself off after any preset number of cycles and indicates when the samples are ready for measurement.

BY MAKING ELECTRICAL CURRENT beat like a heart, only faster, engineers at General Electric can amplify signals so feeble that, by use of a thermocouple, temperature can be regulated with a sensitivity of less than 1/100 of one degree. Principal component of the pulse-type amplifier is a small reactor, about ⅔ the size of a shirt button. It consists of two windings of copper wire around a circular cone made of a saturable magnetic material. The reactors are used in cascade, each one boosting the signal to a higher level. Pulse current enters one of the copper windings, while the signal, converted by conventional means to electrical energy, enters the other winding.

LOGAN . . . a national participant in major fluid power advancements

SINCE 1916



Indianapolis Speedway Memorial Day 500-Mile Race . . . national classic viewed by spectators from every part of the world.

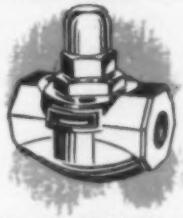
LOGAN HYDRAULIC CONTROL VALVES

Illustrated, Model 409S—4-way, 2-position valve for directing pressure alternately to ends of double-acting hydraulic cylinder.

A broad range of types and sizes to most effectively meet any requirement—Design Engineers, Machine Operators, Maintenance Men appreciate these Logan advantages

- LONG-LIFE CONSTRUCTION
- EASY TO SERVICE
- INFREQUENT MAINTENANCE
- EASE OF INSTALLATION
- EFFORTLESS OPERATION
- UNRESTRICTED PORTING

Let Logan Engineers help you design your Air and Hydraulic Circuits



Illustrated, Model 801S adjustable speed control valve. Install between operating valve and one end of cylinder to meter flow of oil in one direction with free flow on return.

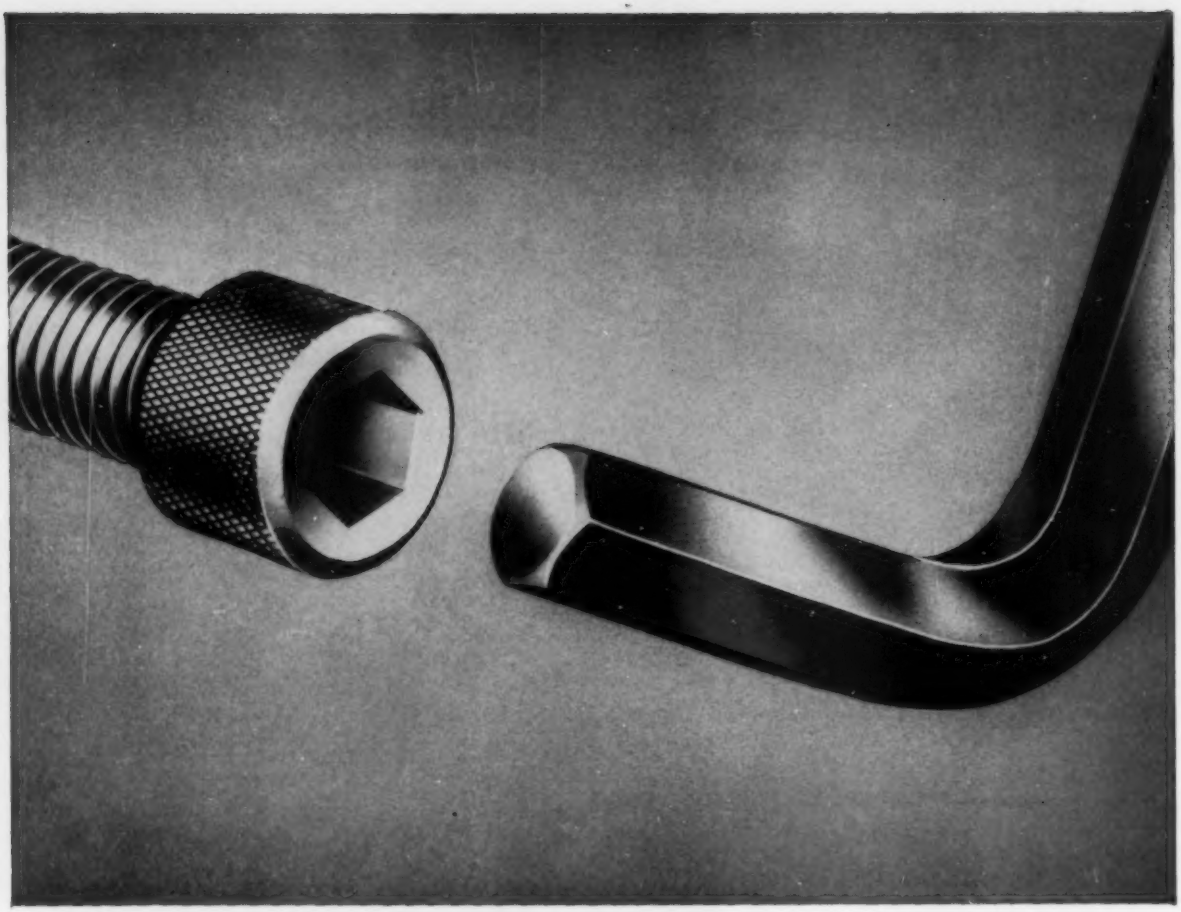
LOGAN MANUFACTURES 6,975 STANDARD CATALOGED ITEMS

FREE CATALOG ON REQUEST

AIR CONTROL VALVES, Cat. 100-4 • AIR CHUCKS, Cat. 70-1 • AIR CYLINDERS, Cat. 100-1 • AIR-DRAULIC CYLINDERS, Cat. 100-3
AIR and HYDRAULIC PRESSES, Cat. 51 • COLLET GRIP TUBE FITTINGS, Cat. 200-5 • HYDRAULIC CONTROL VALVES, Cat. 200-4
HYDRAULIC CYLINDERS, Cats. 200-2; 200-3 • HYDRAULIC POWER UNITS, Cat. 200-1 • SURE-FLOW COOLANT PUMPS, Cat. 62

SAVES TIME Logan AIR AND HYDRAULIC EQUIPMENT EFFORT-MOTION

LOGANSPORT MACHINE CO., INC., 812 CENTER AVE., LOGANSPORT, IND.



Bristol Hex Socket Cap Screws assure speedier, easier, tighter fastening

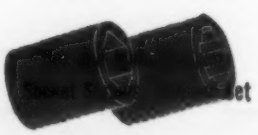
Bristol hex socket cap screws meet every production and maintenance requirement.

They spin easily into place, fit perfectly, and wrench up tightly, even in hard-to-get-at places. They take the wrench without skidding, too, so there's no danger of marring surfaces. Disassembly is just as easy. And Bristol's hex socket screws can be tightened far beyond the point where shock or vibration will loosen them.

This extra holding power results from the hex socket design, and Bristol's careful control over materials and manufacturing methods. Standard hex socket cap screws are made of alloy steel specially hardened. Other special metals and finishes may also be supplied. All Bristol screws are A.S.A. approved and precision threaded either National Coarse or National Fine.

Ask for Bristol hex socket cap or set screws in sizes from 0 wire to one inch in diameter at your industrial distributor's.

BRISTOL'S SOCKET SCREWS

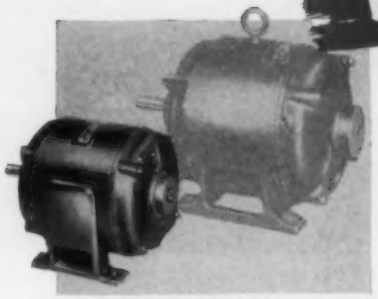


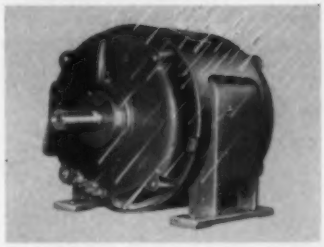
THE BRISTOL COMPANY, Socket Screw Division, Waterbury 20, Conn.

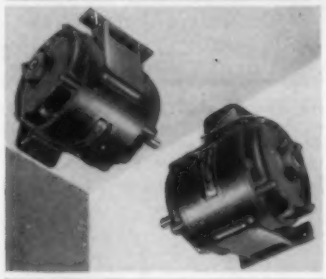
NEW Century Performance-Rated® INTEGRAL H.P. MOTORS

Now available in
1 . . . 1½ . . . 2 H.P. sizes—
NEMA frames 182 and 184.

Improved Motors to match your needs







869-A

SMALLER — LIGHTER

More uniform silicon-laminated steel; thinner, *tougher* "Mylar" slot insulation — just two of the many technical developments that help make these new Century Performance Rated Motors so much *smaller* and *lighter*.

BETTER PROTECTION

New concepts of internal motor ventilation permit end bracket and frame design that gives far better protection from falling liquids and solids . . . still maintain 40°C. temperature rise.

MORE FLEXIBLE MOUNTING

You can even have cushion mounting with these new Century Integral H.P. Motors — your choice of sleeve or ball bearings. Ball bearing motors mount vertically, upside down, in any position. End brackets can be rotated for top protection in any position.

EVEN MORE DEPENDABILITY

Improved plastic impregnating varnish and plastic insulated magnet wire provide unusual resistance to abrasion, moisture and heat. These new materials possess far better dielectric qualities. Die cast aluminum rotors are individually, dynamically balanced to assure freedom from vibration.

Century C MOTORS

Call Your Century Application Engineer . . .
Ask him about the new Century Performance Rated Integral and Fractional H.P. Motors.

Offices and Stock Points in Principal Cities

CENTURY ELECTRIC COMPANY • 1806 Pine Street • St. Louis 3, Missouri

STOW flexible shafting drives this conveyor used to feed ducks. Owned by Mr. Harry Baker of East Port, Long Island.

STOW flexible shafting on the job in AGRICULTURE!

Here are just a few of the many ways STOW Flexible Shafting is being used in agricultural applications. 75 years of experience has given us that all-important know-how you'll find so helpful in working out power transmission and remote control problems on your agricultural equipment.

SHAFTING AVAILABLE IN SIZES 1/8" to 1 5/8"

TRANSMITS UP TO 10 HP

STANDARD TERMINALS AVAILABLE. special terminals for particular applications

WRITE TODAY FOR FREE AIDS!

Send for FREE Torque Calculator! Gives you the information you need simply, quickly. Eliminates lengthy calculation. Write today, on your company letterhead.

Write today for your free copy of Bulletin 525 containing complete engineering data on STOW flexible shafting.

STOW MANUFACTURING CO.

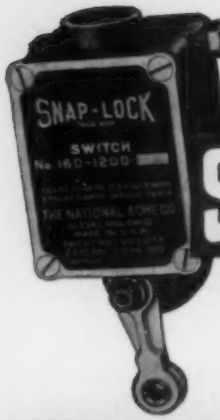
426 State St., Binghamton, N. Y.

STOW flexible shafting powers this Avery Rake, built by the B. F. Avery Division of Minneapolis Moline Company, Louisville, Ky.

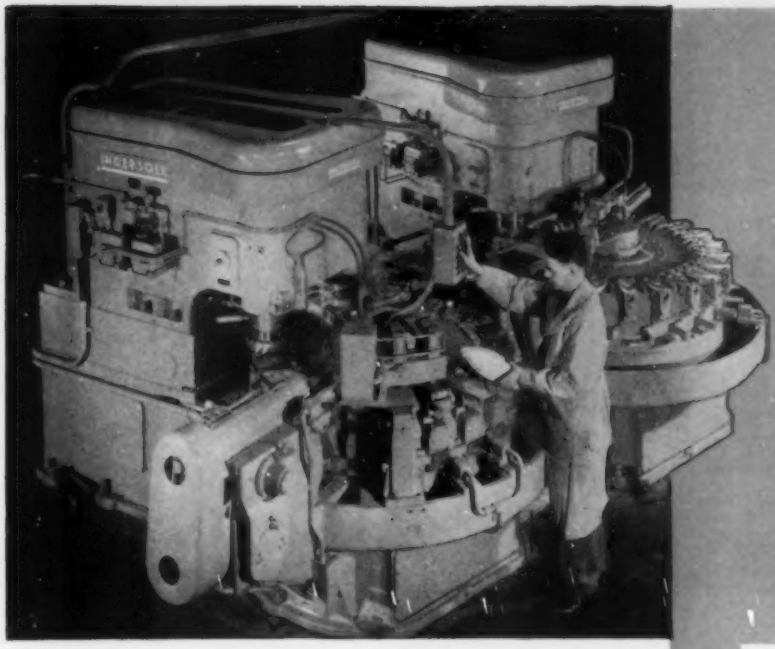
STOW flexible shafting drives the feed conveyor on this G.L.F. bulk feed delivery unit operated by Broome G.L.F. Elevator.

STOW flexible shafting transmits power from the accessory gear box to the pump of the Aero Mist Master, manufactured by Mabry I. Anderson, Mississippi Valley Aircraft Service.

STOW flexible power drive shaft operating telephone pole hole digger. Courtesy of American Telephone and Telegraph Co.



SNAP-LOCK TRADE MARK plays a vital part in new plant-automation plans



TWO COMPARTMENTS

sealed off—self-protected

ELECTRICAL SIDE

Accessible wiring connections, self wiping coin silver contacts, no arcing, heavy insulation throughout, oil and dust resistant case. Single pole, double break, double throw —positive lock in ON or OFF position.

MECHANICAL SIDE

Hardened steel parts, strong spring, rugged, compact construction, wide choice of operating levers. Snap-Lock is guaranteed mechanically and electrically for any normal circuit application.

Snap-Lock is the heavy duty limit switch—quick acting, positive, dependable—built *by* machine tool builders *for* machine tool builders.

In the 15 years since we first designed Snap-Lock to meet our own machine tool needs, it has been adopted as the standard switch equipment by 4 out of 5 of all builders of precision operated machine tools. Hundreds of users of other types of equipment also specify Snap-Locks—where control is vital, where lasting and service-free life is more important than mere price.

If you have a switch problem, choose from the wide variety of Snap-Lock standard types with regular or special mountings or, if you need a special application, let our engineers help you design Snap-Lock into your product.

Ask for Engineering Bulletin EM-51

INGERSOLL says:

"For this special model, again we rely on 13 Snap-Lock switches to insure correct sequencing of all 6 operations for automatic milling of tops, bottoms and sides of sole plates for electric flat irons at 1000 per hour-- fastest rate ever attained."

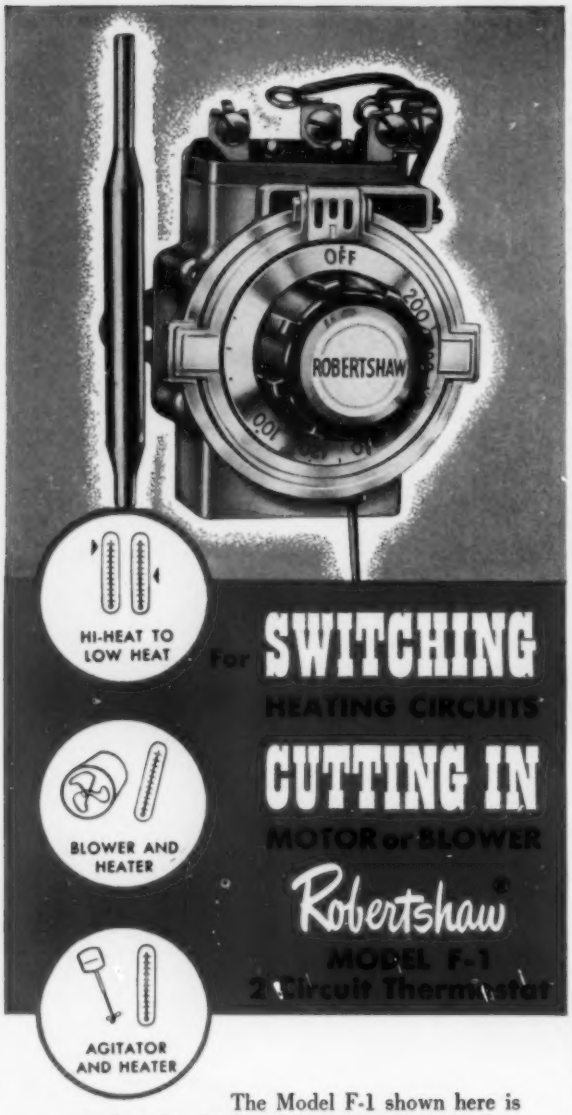
The Ingersoll Milling Machine Co. at Rockford, Ill., top flight builders of precision automatic milling, boring and drilling machines, have for years standardized on Snap-Lock limit switches.

ELECTRICAL MANUFACTURING DIVISION

The NATIONAL ACME COMPANY

170 EAST 131st STREET • CLEVELAND 8, OHIO

ACME-GRIDLEY
BAR and CHUCKING AUTOMATICS
1-4-6 and 8 Spindle • Hydraulic Thread Rolling Machines • Automatic Threading Dies and Taps • Limit, Motor Starter and Control Station Switches • Solenoids • Contract Manufacturing



The Model F-1 shown here is a single pole, double throw thermostat used to switch circuits from high to low heat where two heating elements are used. For example, an appliance may have one heating element with 4500 watt capacity and a heat holding element with 1000 watt capacity. When the thermostat calls for heat, the 4500 watt element is in action. When the desired temperature is reached, the main contacts are broken, the low heat element is cut in and the 1000 watt element will function until a drop in the temperature causes the thermostat to operate and switch contacts back to the 4500 watt element.

May be used to operate fans in air duct or agitators in tank, etc., in combination with heaters when desired. *Write for Catalog.*

Robertshaw-Fulton
CONTROLS COMPANY

ROBERTSHAW THERMOSTAT DIVISION, YOUNGWOOD, PENNSYLVANIA

What is YOUR PRODUCTION PROBLEM?

Investment Castings by **ARWOOD** will solve these problems.

ALLOY High strength, hard to machine alloys are cast, eliminating production and performance problems.

MACHINING Tricky shapes, involving complicated machining, are investment cast to shape.

ASSEMBLY Several small parts can be cast as one unit, eliminating assembly.

★

For complete details on the process we will gladly furnish our booklet "Alloy Selection and Design for Precision Casting".

★

ARWOOD offers:

CAPACITY 4 production plants with complete tooling facilities.

METALS Castings in all ferrous and non-ferrous alloys including magnesium.

QUALITY CONTROL Air Force approved X-ray and heat treating facilities. Physical testing equipment and metallographic laboratories.

SERVICE Sales engineers in every large industrial center of the country.

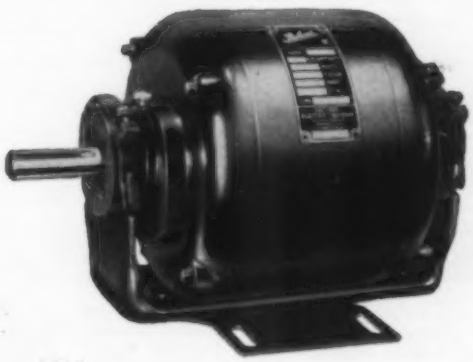
ARWOOD
PRECISION CASTING Corp.
68 WASHINGTON STREET BKLYN 1, N. Y.
Plants: Brooklyn, N. Y. • Groton, Conn. • Tilton, N. H. Los Angeles, Cal.

THE MAINSTAY OF YOUR BUSINESS-

is a *satisfied customer!* And it's easy to keep your customers satisfied when you use Packard Electric motors in your product. These dependable motors have a world-wide reputation for long life and trouble-free operation . . . important qualities that help to assure continued customer satisfaction.

You benefit in two ways when you standardize your production with Packard fractional horsepower electric motors. First, you have the Packard Electric name working for you in gaining customer acceptance. Second, you have the Packard Electric motor working for you in gaining customer satisfaction.

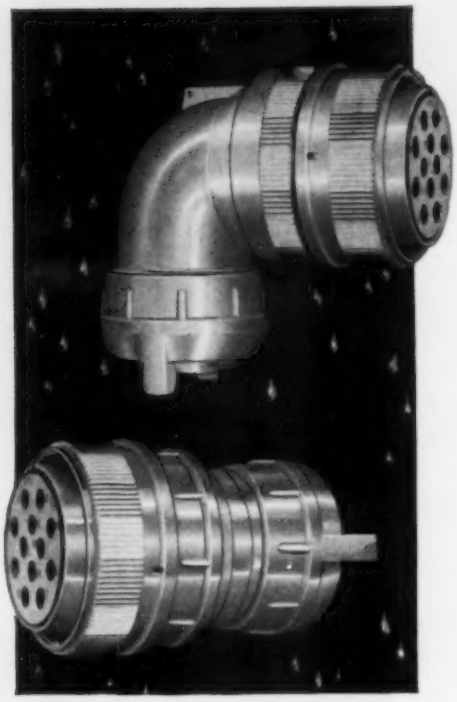
A COMPLETE LINE OF RUGGED
FRACTIONAL HORSEPOWER APPLIANCE MOTORS



GM GENERAL MOTORS Packard
REG. U.S. PAT. OFF. TRADE MARK

Packard Electric Division, General Motors Corporation, Warren, Ohio

NOW!



BENDIX·SCINFLEX WATERPROOF PLUGS

for use with multi-conductor cables

These new Bendix*-Scinflex *waterproof* plugs are a modification of our standard AN type "E" (environment resistant) connector. They are designed to meet all "E" performance requirements when used with multi-conductor cables. Each plug includes a modified AN3057B cable clamp which provides inward radial compression on multi-conductor cables. This unique feature completely eliminates cable strain—a common source of circuit trouble.

In addition, there are gaskets at all mating surfaces and an accessory sleeve is available to accommodate an extreme range of cable sizes. A folder describing this new waterproof plug—and the various sizes in which it is manufactured—may be obtained by writing our Sales Department. *REG. TRADE-MARK

THESE BUILT-IN FEATURES ASSURE TOP PROTECTION AGAINST CIRCUIT FAILURE:

Shock and Vibration Resistant • Die Cast Aluminum Shell • Cadmium Plate—Olive Drab Finish • Moisture-Proof, Pressurized • High Arc Resistance, High Dielectric Strength Silver-Plated Contacts • Resilient Inserts

Bendix

SCINTILLA DIVISION

Bendix AVIATION CORPORATION

SIDNEY, NEW YORK

Export Sales:
Bendix International Division
205 East 42nd St., New York 17, N.Y.

Factory Branch Offices: 117 E. Providencia Avenue, Burbank, California • Brouwer Building, 176 W. Wisconsin Avenue, Milwaukee, Wisconsin • Stephenson Building, 6560 Cass Avenue, Detroit 2, Michigan • 512 West Avenue, Jenkintown, Pennsylvania • 8401 Cedar Springs Rd., Dallas 19, Texas • American Building, 4 South Main Street, Dayton 2, Ohio

New Catalog!

MERCURY PLUNGER RELAYS

For One, Two and Three Pole Applications

Millions of Trouble-Free Operations
Built-in Economy and Reliability

Carries up to 60 Amps.
Motor Loads up to 3 HP.
Hermetically Sealed
Explosion-Proof
Silent, Cool Operating
Non-Contaminating
Maintenance-Free
Mercury-to-Mercury

Send for **FREE CATALOG** and 30-day test details

EBERT ELECTRONICS CORP.
212-27 JAMAICA AVE., QUEENS VILLAGE 28, N. Y.

NO COMPETITOR DARES COPY

Your Name Plate

Make it WORTHY Of Your Product

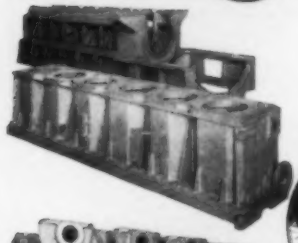
As the maker's "signature," your name plate is one thing that can set your product apart from all others. Make it *distinctive*, and let it reflect the quality you offer.

Let us help you create such a "signature." Our skilled craftsmen, long experience and modern equipment insure finest results. Send a rough sketch or blueprint for design suggestion and quotation.

Write now for "Etched or Lithographed Metal Products," with full color examples of name and instruction plates.

CHICAGO THRIFT-ETCHING CORPORATION
1555 N. SHEFFIELD AVE., CHICAGO 22, ILL., DEPT. B
SUBSIDIARY OF DODGE MANUFACTURING CORPORATION, MISHAWAKA, INDIANA

Use WELDED STEEL
for Greater Strength
with Less Weight!



The 86-foot pressure vessel illustrated above is a Stabilizer built for a petroleum refining plant. This unit and its Overhead Receiver were Steel-Weld Fabricated by Mahon in accordance with the A.S.M.E. 1952 Code. Platforms, Ladders, and other miscellaneous iron, to complete this unit in the field, were also produced by Mahon. Equipment of this type, and the products, parts and assemblies shown at the left are typical of thousands of Steel-Weld Fabricated units produced and machined by Mahon for hundreds of processing plants and manufacturers of processing machinery, machine tools, and other types of heavy mechanical equipment. Perhaps you, too, could profit by discussing this unique service with a Mahon engineer. If you require special equipment, or parts or assemblies including large, heavy pieces, where time and pattern costs are a consideration, Mahon Steel-Weld Fabrication may prove to be the answer. You can turn to Mahon with complete confidence . . . personnel and facilities are available within the Mahon plant to do the entire job from drawing board to finished machining. You will find in the Mahon organization a reliable source with ultramodern fabricating, machining and handling facilities to cope with any type of work regardless of size or weight. See Mahon's Insert in Sweet's Product Design File, or have a Mahon engineer call at your convenience.

THE R. C. MAHON COMPANY
DETROIT 34, MICHIGAN

Engineers and Fabricators of Steel in Any Form for Any Purpose

MAHON

Private "air truck" for Very Special Delivery

. . . powered by Lycoming

When deliveries are *Rush* with a capital "R" . . . today's progressive businessman turns to a small company plane that relieves him of dependence on the schedules of commercial air-freight systems.

Take the case of the Capital City Printing Plate Company of Des Moines, Iowa . . . operator of a Piper Tri-Pacer powered by Lycoming. Gene C. Meston, General Manager, says: "We could not maintain our production and sales level without the Tri-Pacer. The airplane and the pilot do the work of two trucks and three drivers. We save a lot of expense and keep our customers well satisfied."

Our own experience at Lycoming with the Tri-Pacer is a revelation in dollars and cents. It carries a 500-lb. payload at an operating cost of only 5.6¢ per mile . . . *less than the average cost of running an automobile!*

For the "air truck" in *your* future, test-fly a Piper . . . or one of the other leaders in this small-plane field that fly with dependable Lycoming air-cooled engines.

Off again to deliver the goods! Tom Vodenik, Capital City pilot, shown here, says: "We logged over 750 hours in the first eight months we flew this Tri-Pacer. The plane has had nothing but routine maintenance—it's ready to go every day!"

Just off the press! "The Lycoming Story" . . . 40 interesting, illustrated pages showing many ways Lycoming is ready to help you. Write for it on your letterhead.

FOR RESEARCH • FOR PRECISION PRODUCTION

LOOK TO **Lycoming**

DIVISION OF AVCO STRATFORD, CONN.

Manufacturing plants in Stratford, Conn., and Williamsport, Pa.

Superior

TYPE 430

STAINLESS STEEL

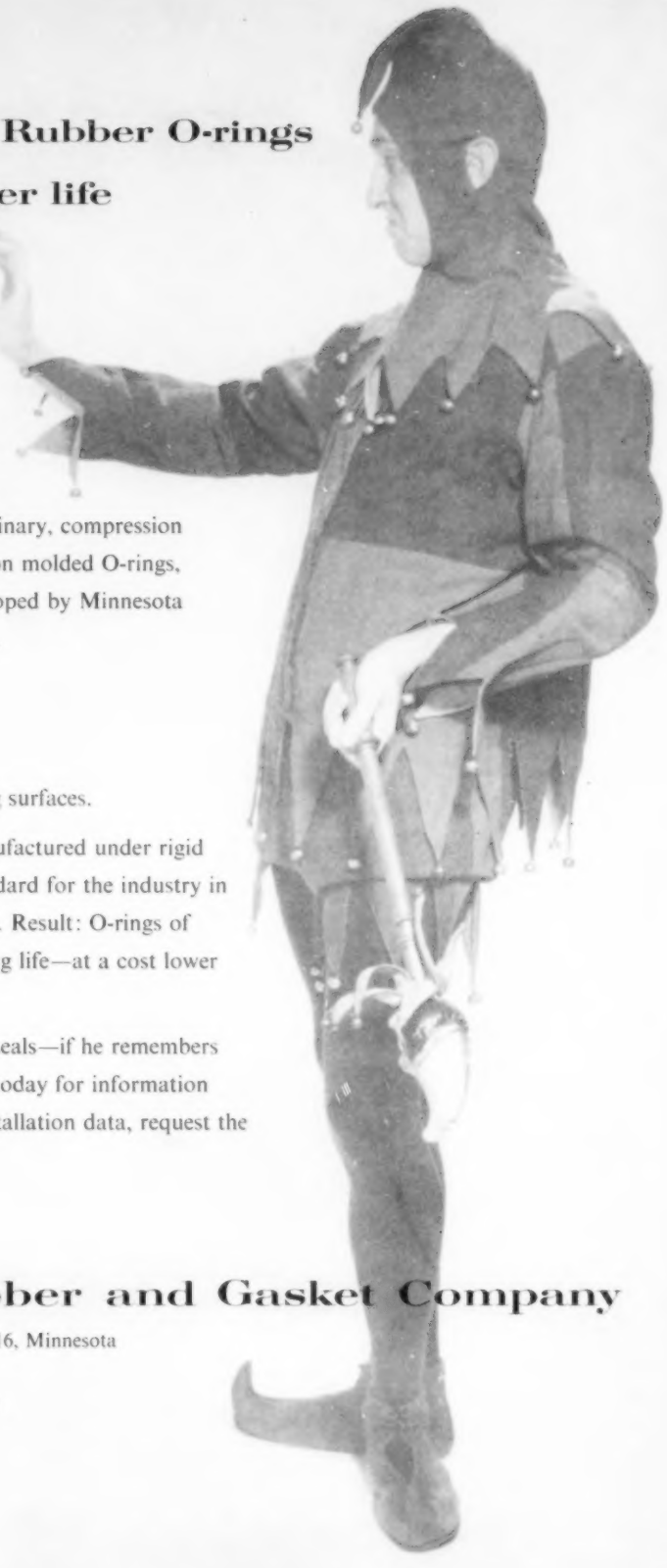
The Heart of the Lighter

FOR HEAT RESISTANCE
RESISTANCE TO CORROSION
EASE OF FABRICATION
UNIFORM HIGH QUALITY

This famous lighter has a stainless heart that never fails in service 'round the world. ○ Because it is made of versatile 430 Stainless, the lighter body never rusts, always extracts readily for filling, is unaffected by heat or flame—and fabricates faultlessly in the first place! ○ We can supply your stainless needs with Type 430 in specified dimensions and finishes. Send us your inquiry.

Superior Steel
CORPORATION
CARNEGIE, PENNSYLVANIA

Why Minnesota Rubber O-rings have longer life



Long use in the finest mechanical, electrical and hydraulic applications has proved injection molded O-rings last longer than ordinary, compression molded seals. Why? Because injection molded O-rings, made by the exclusive process developed by Minnesota Rubber, include such features as . . .

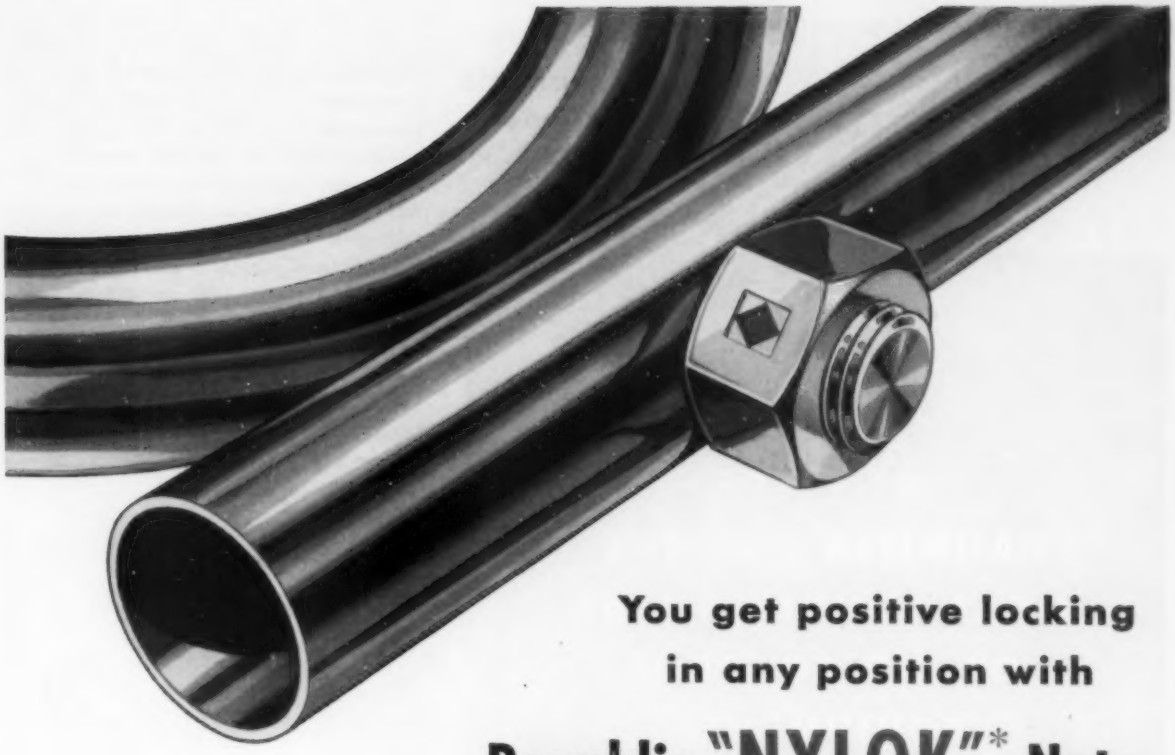
- no troublesome flash.
- tolerances within ±.001 inch.
- extremely high density.
- no trimming blemishes on sealing surfaces.

Minnesota Rubber O-rings are manufactured under rigid quality controls that have set a standard for the industry in high performance and dependability. Result: O-rings of greater tensile strength, longer flexing life—at a cost lower than the industry average!

Now *anyone* can find better O-ring seals—if he remembers the name *Minnesota Rubber*. Write today for information and prices. For complete O-ring installation data, request the new free catalog 9-B.

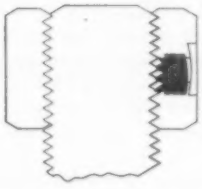
Minnesota Rubber and Gasket Company

3630 Wooddale Avenue, Minneapolis 16, Minnesota
Dept. 303
Phone MOhawk 9-6781



You get positive locking in any position with

Republic "NYLOK"* Nuts



Here's how the "Nylok" principle works
A nylon plug inserted in one of the sides of the cold-forged nut forces the nut tightly against the opposite threads as the nut is turned on.

*U. S. Pat. No. 2,462,603 and No. 2,450,694 and pending applications.

Locking is positive even when the "Nylok" Nut is seated against a tubular section. And there's no need to pull Republic "Nylok" Nuts up tight. They lock wherever you stop wrenching—eliminating the need for lock washers.

These lock nuts are simple to apply. Either end is up. No special tools, lubricants or techniques are needed. Republic "Nylok" Nuts can be re-used.

Does this give you an idea for your product? Write us for samples, indicating sizes required.

12 WAYS BETTER

Assemble from either end • Can be re-used • Non-galling • Best wrenching characteristics • One-piece • Cold-forged • Won't damage threads No special tools • Lock in any position • No special know-how • No lubricants needed • Ideal for mechanical feeding

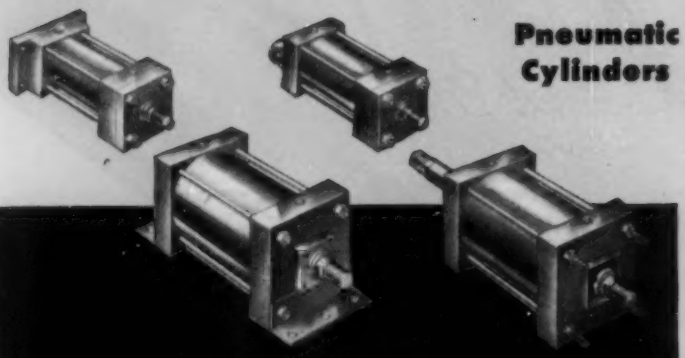
SIZES

Finished Series tapped ¼" through 1"
Finished Thick Series tapped ¼" through ½"
Heavy Series tapped ¼" through 1"

REPUBLIC STEEL CORPORATION
Bolt and Nut Division • Cleveland 13, Ohio
GENERAL OFFICES • CLEVELAND 1, OHIO
Export Department: Chrysler Building, New York 17, New York

REPUBLIC BOLTS AND NUTS

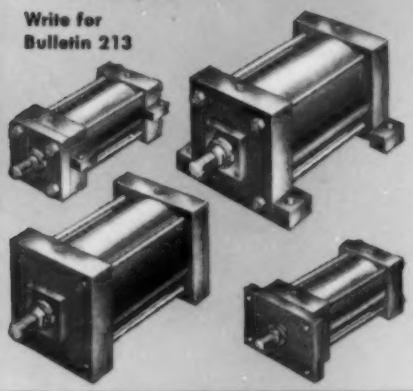
REPUBLIC STEEL



Pneumatic Cylinders

Hannifin Series "A" Square Type Pneumatic Cylinders are made in 11 bore sizes from 1½" to 14"...are available with 13 standard mountings, many combination mountings. All tooling is to extremely close tolerances to insure accurate, easy mounting. Cylinders are micro-honed and piston rods are ground and polished. Heavy-duty tie rods. Exclusive bronze cartridge gland is easily removed without dismantling the entire cylinder.

Write for Bulletin 213



NOW...

HANNIFIN HAS THE MOST COMPLETE LINE OF AIR CONTROL EQUIPMENT!

NEW! REVOLUTIONARY HANNIFIN *P-M Pilot-Master Valves*

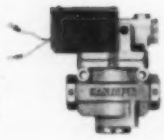
Piston-operated poppet design. Exclusive replaceable cartridge for easier maintenance. Speeds to 600 cycles per minute. Pressure from 15 to 150 p.s.i. Integral, solenoid-controlled pilot heads or a choice of 10 separate pilot valves for remote control.

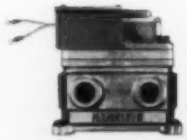
- Fewer Valves to Stock
- Fewer Parts to Stock
- Maximum Interchangeability
- No Springs in Main Valve

Write for Bulletin 231.

2 and 3-Way Valves.

Same valve operates 2-way or 3-way, normally open or normally closed. ⅜" to 1¼" I.P.S.

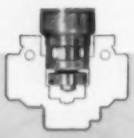




4-Way Valves.

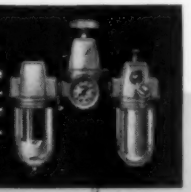
Two 3-way valves mounted in compact, common body. Two piston poppets. Two cartridges. ⅜", ½", ¾" I.P.S.

EXCLUSIVE REPLACEABLE CARTRIDGE



AIR WARDEN

Air filters, pressure regulators and lubricators to protect air operated equipment. Bulletin 1010B.



Disc Type Air Control Valves

Designed for smooth, positive and accurate control of air-operated equipment. Bronze discs lapped to perfect seal with seats. Packless design. For hand, foot or electrical operation. Sizes: ⅛" to 1¼" I.P.S.

Write for Bulletin 57-W

Hannifin "Directair" electrically controlled air-operated disc valve

Foot-operated treadle valve (Also spring return and rotary types)

Standard hand control valve (Single or duplex)

HANNIFIN

Hannifin Corporation, 525 Wolf Road, Des Plaines, Ill.

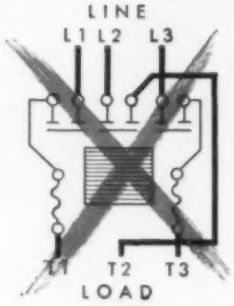
Air and Hydraulic Cylinders • Hydraulic Power Units • Pneumatic and Hydraulic Presses • Air Control Valves

Time-...Cost-...Space-Saving STRAIGHT-THRU WIRING

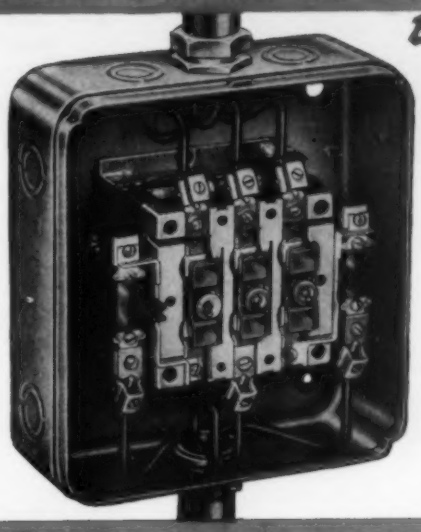
...one of many *Advanced Design* features of

ARROW·HART TYPE "RA" MAGNETIC MOTOR CONTROLS

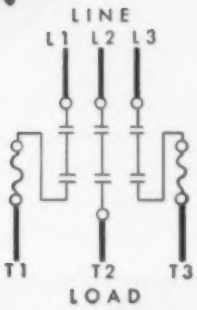
NOT THIS...



with
Conventional Wiring
3 Phase



BUT THIS!



A-H Straight-Thru Wiring
3 Phase

Time a factor? ***Cost*** an object? ***Space*** at a premium? If any — or all — of these considerations ***must*** influence your choice of motor controls . . . then your choice ***should be*** Arrow-Hart Type "RA" (Right Angle) Motor Controls with STRAIGHT-THRU WIRING.

A-H STRAIGHT-THRU WIRING—an in-built feature—***not*** just a bus-bar arrangement — effects important space savings . . . eliminates the need for crossing, looping or U-bending . . . makes installation and maintenance much faster and less costly . . . provides safer direct routing with greater separation of line and load . . . assures immediate certain identification of circuits.

Add to the time, cost and space considerations the plus-performance requirement and you add another reason for choosing "RA" Motor Starters. Only Arrow-Hart's "RIGHT ANGLE" OPERATING MECHANISM makes it possible to build improved performance into controls that are smaller and lighter by far than any others of comparable rating.

Arrow-Hart's line of Type "RA" (Right Angle) Magnetic Across-The-Line Starters offers the greatest advance in design — ***and*** performance — available ***anywhere.***

MAIL COUPON **Today!**

FOR FREE FOLDER "THE BIG STORY"

SINCE 1890

ARROW · HART
INDUSTRIAL CONTROL DIVISION
103 HAWTHORN ST., HARTFORD 6, CONN., U.S.A.

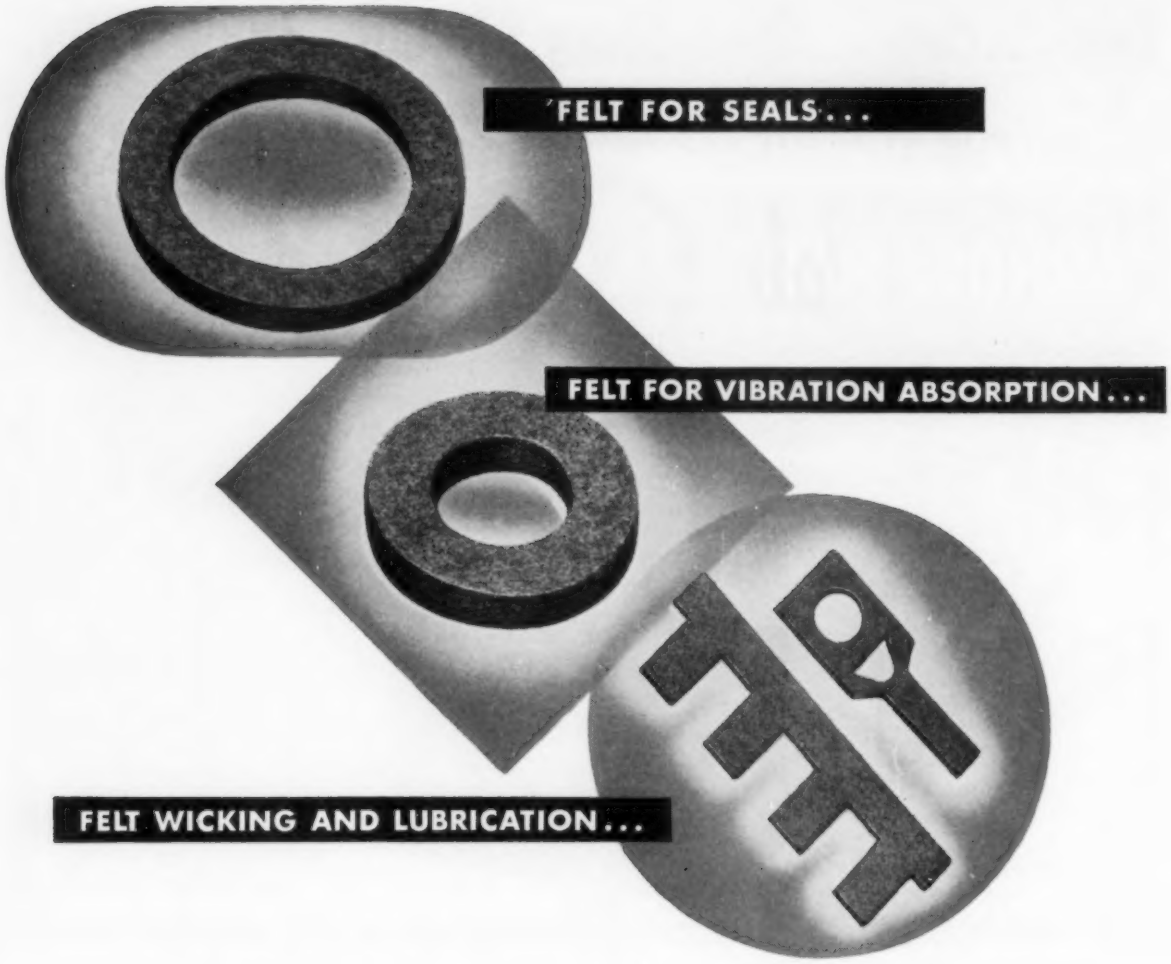
Offices, sales engineers and warehouses in: Atlanta, Boston, Buffalo, Chicago, Cincinnati, Cleveland, Dallas, Detroit, Houston, Indianapolis, Los Angeles, Milwaukee, Minneapolis, New York, Philadelphia, Pittsburgh, St. Louis, San Francisco. **In Canada:** Arrow-Hart & Hegeman (Canada) Ltd., Mt. Dennis, Toronto. **In England:** Arrow Electric Switches, Ltd., Ealing, London W3.

Quality MOTOR CONTROLS • WIRING DEVICES
ENCLOSED SWITCHES • APPLIANCE SWITCHES

INDUSTRIAL CONTROL DIVISION
THE ARROW-HART & HEGEMAN ELECTRIC CO.
103 HAWTHORN STREET, HARTFORD 6, CONN.

Please send me my copy of the folder, "The Big Story."

NAME _____
POSITION _____
COMPANY _____
COMPANY ADDRESS _____
CITY _____ ZONE _____ STATE _____
PE



...and Always to Your Exact Specifications!

Western Felts are highly versatile! That's one of their tremendous advantages wherever you can use a felt component to help the performance of your product. We start with the very picking and carding of the millions of tiny wool fibres, with every process in our plant under our complete control!

Western Felts are made soft and springy, dense and hard, or of any of the unlimited degrees of density in between. They are conditioned for the exact jobs they are to perform, right down to the precision cutting to extremely close tolerances. Especially in the more dense consistencies, tolerances often are as close as a few-thousandths of an inch!

Wear, age and weather do not affect Western Felt parts. They deaden sound, seal against dust, greases and oils, or they are made to absorb and feed oil when used for lubrication...*exactly* as you wish. Western Felt parts can be chemically treated for hardness, waterproofing, mothproofing, oil retention, abrasion resistance...or greater tensile strength.

Western Felt components will help solve many of your problems. You are invited to consult with our engineers.

WESTERN Felt WORKS

4021-4139 W. Ogden Ave.
Chicago 23, Illinois
Branch Offices in Principal Cities

MANUFACTURERS AND CUTTERS OF WOOL FELT

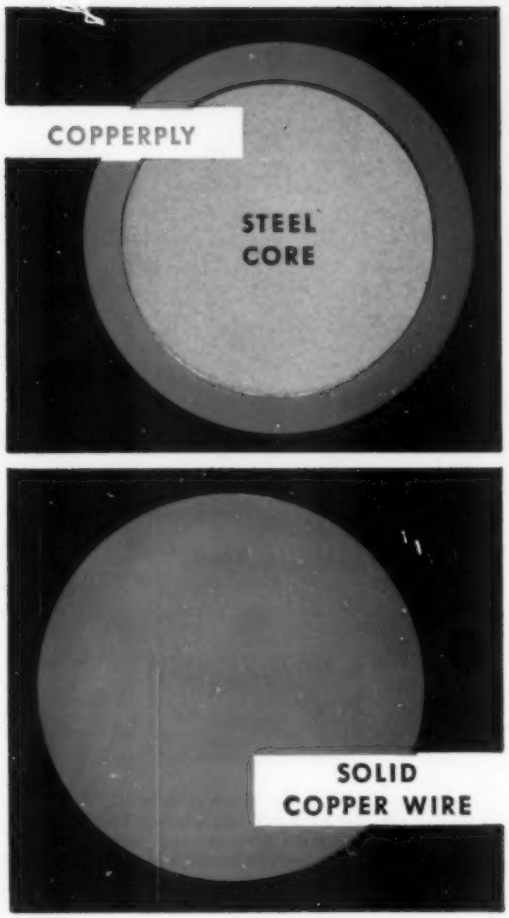
cost-cutting

stronger

more dependable

Now available..COPPERPLY®

A NEW COPPER-PLATED STEEL WIRE
OF UNMATCHED NATIONAL-STANDARD QUALITY



COPPERPLY, accurately concentric and uniform, is steel wire electroplated with copper to the thickness required. This type wire was originally used for television lead-in installations. Now this unique wire is solving cost problems in many new applications.

Maybe COPPERPLY gives you ideas for applications in your field . . . uses that will result in substantial savings over solid copper wire.

In addition to cutting costs, COPPERPLY obviously is much stronger than copper wire. And National-Standard makes it with a regular or high tensile steel wire core to fill your specific requirements.

We'll "loan" you an engineer to help you develop any ideas for using COPPERPLY you'd like to explore. It's company policy to give the best service in the industry, in addition to the highest quality special wire and steel products available. Write the National-Standard Company, Niles, Michigan, concerning COPPERPLY. Write the appropriate division listed below on other products.

DIVISIONS OF
NATIONAL-STANDARD

NATIONAL-STANDARD Company
NILES, MICHIGAN

Athenia Steel, Clifton, N. J.
Flat, High Carbon, Cold Rolled Spring Steel

National-Standard, Niles, Mich.
Tire Wire, Stainless, Fabricated Braids and Tape

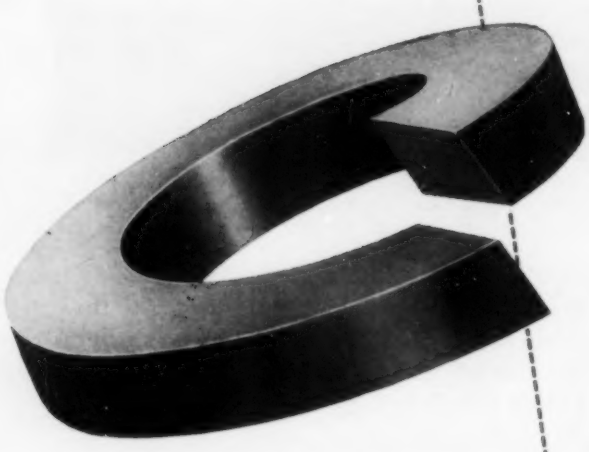
Reynolds Wire, Dixon, Illinois
Industrial Wire Cloth

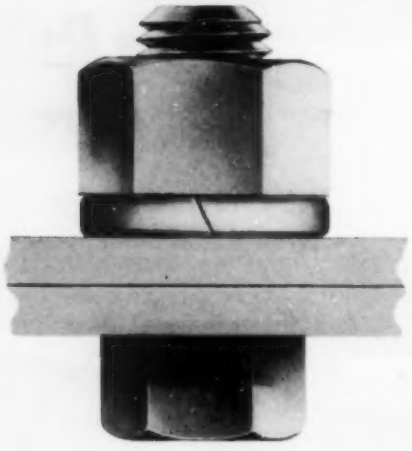
Wagner Litho Machinery, Jersey City, N. J.
Metal Decorating Equipment

Worcester Wire Works, Worcester, Mass.
Round and Shaped Steel Wire, Small Sizes

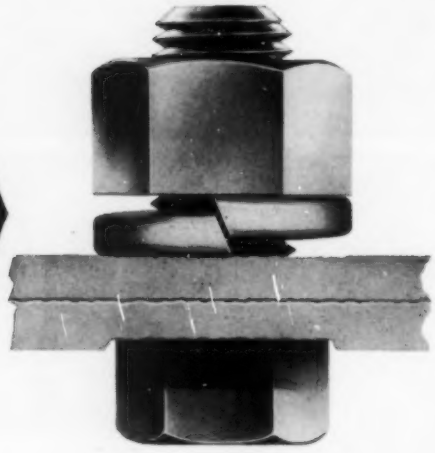
When we say "spring"...

WE MEAN SPRING





Tight—a nut wrenched home sets up great pressure on threads and between all parts.



Still tight. Though the nut never turned, the other parts wore and stretched. The assembly would have loosened except for the wide range of spring power.

No other device has the power and the long range of live spring action given you by a Kantlink Spring Washer.

Parts wear loose because of bolt stretch and frictional wear of metal on metal, burrs and flares, and because of pulverizing of paint, scale and rust.

Kantlinks are being used with millions of nuts, bolts and screws of all types. They keep expanding to hold all parts **tight** despite inevitable wear.

In ordering spring washers—specify **Kantlink,** the big long range live spring washer.

KANTLINK TRADE MARK

the long-range Spring Washer

THE NATIONAL LOCK WASHER COMPANY

Newark 5, New Jersey **Milwaukee 2, Wisconsin**

Mr. Paul Herr, director of Air Conditioning Division, Daffin Manufacturing Co., Lancaster, Pa., tells why they use Aico Molded Plastics:

. . . being determined to produce a really efficient home humidifier, we realized the importance of precision craftsmanship in all its parts. When we were faced with the need for extreme precision in the plastic pump impeller we planned to use, a friend suggested we turn the job over to American Insulator. Ever since, Aico has been supplying us production run parts held to a .005 tolerance. A remarkable example of precision plastics molding!"

New **Daffin** home humidifier

keeps profits from drying up

by replacing 8 metal parts

with molded plastics impeller

THERE are many ways plastics can reduce manufacturing costs. The Daffin impeller is a good example. Instead of buying numerous separate parts, many of them having to be machined, Daffin Manufacturing simplified purchasing, eliminated many assembly operations . . . and obtained more efficient operation by using one plastic molding. And, because Aico is so completely equipped as a molder, Daffin was able to obtain the other important parts for their new humidifier from *one* source and further reduce costs. If you have a similar need for plastics, get in touch with Aico today

Let Aico help you use plastics

We have prepared several useful tools to help you get the full production and cost saving benefits of molded plastics. Just check the coupon for the ones you want. There's no obligation.

Please send me

____**The Aico Plastics Applicator** (gives complete properties, molding methods, etc.)

____**"What you should know about Reinforced Plastics"** (applications, properties and molding)

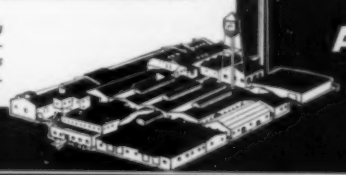
____**Aico Plant Facilities Booklet** (what a modern molder needs to produce precision plastic moldings)

*Name*_____ *Position*_____

*Company*_____

*Address*_____

***Complete plastics molding service** including engineering counsel, mold making, compression, injection and cold molding as well as the molding of reinforced plastics.*



AMERICAN INSULATOR

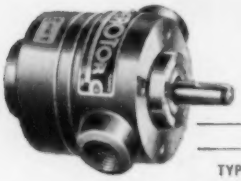
Since 1916

NEW FREEDOM, PA.

There's a Gerotor Hydraulic Pump

to meet your requirements!

The GEROTOR line of precision engineered hydraulic pumps is designed to fill the requirements of the majority of hydraulic equipment users. The three standard GEROTOR models cover a range of g.p.m. delivery from .4 g.p.m. to 40 g.p.m. Check the capacity tables for the pump to fill your needs.



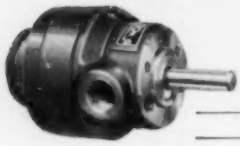
TYPE QDB

Gerotor's NEW QDB series of small capacity pumps . . . the last word in precision engineering.

DELIVERY G.P.M. — 1800 R.P.M.

TYPE	DISCHARGE PRESSURE P.S.I.				
	0	250	500	750	1000
QDB .4	.42	.40	.38	.35	.31
QDB .75	.84	.80	.78	.73	.66
QDB 1.5	1.67	1.62	1.57	1.50	1.42

Capacity Table



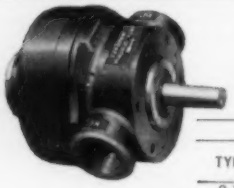
TYPE QDH

The QDH . . . popular intermediate size of the Gerotor line

DELIVERY — G.P.M. AT 1200 R.P.M.

TYPE	DISCHARGE PRESSURE P.S.I.						
	0	250	500	750	1000	1200	1500
QDH 3	3.3	3.2	3.1	3.0	2.9	2.7	2.5
QDH 5	5.6	5.4	5.3	5.2	5.1	4.8	4.4
QDH 8	8.6	8.5	8.4	8.3	8.2	8.1	7.8
QDH 12	12.9	12.8	12.7	12.5	12.3	12.2	11.8

Capacity Table



TYPE O

Gerotor Series O . . . when larger capacities are needed

DELIVERY — G.P.M. AT 1200 R.P.M.

TYPE	DISCHARGE PRESSURE P.S.I.				
	0	250	500	750	1000
O-20	20.0	19.5	18.8	18.0	17.2
O-25	25.0	24.5	24.0	23.2	22.2
O-30	31.2	31.0	30.5	29.8	29.0
O-40	43.0	42.5	42.0	41.5	40.0

Capacity Table

Whatever your needs in hydraulic pumps . . . consult the GEROTOR engineers. Write for FREE literature and information, no obligation, of course.

GEROTOR MAY CORPORATION
P. O. Box 86—Baltimore 3, Maryland

GEROTOR

HYDRAULIC PUMPS—HYDRAULIC MOTORS

Pneumatic Bin Evacuators — Precision Contract Manufacturing

A.C.M.I. BORESCOPES

for close-up visual inspection of internal surfaces and hidden parts

A.C.M.I. Borescopes are available in 4 angles of vision (as above)—in diameters of .120" to 4.00" —in lengths of 4" to 720". Special models for special problems.

A.C.M.I. Borescopes permit close-up visual examination of interior areas and surfaces not otherwise visible. They save time and money, and prevent costly dismantling. • Each Borescope is a compact, self-illuminated industrial telescope of highest quality, employing a precision optical system, that produces a flat visual field. Lens systems are fully corrected for color, spherical aberrations, and coma, with all lens surfaces coated to increase light transmission

Write for free informational folder, or tell us your problem.

American Cystoscope Makers, Inc.
1241 LAFAYETTE AVENUE NEW YORK 59, N. Y.

CERAMIC and CERAMET COATINGS

FOR HIGH TEMPERATURE METALS

•RESEARCH •DEVELOPMENT •PRODUCTION

WRITE, PHONE OR WIRE

Sales Representatives Throughout the World — SINCE 1901

THE **O. HOMMEL CO.** PITTSBURGH 30, PA.

POTTERY • STEEL AND CAST IRON FRIT
CERAMIC COLORS • CHEMICALS • SUPPLIES
Our Technical Staff and Samples are available to you without obligation. Let us help solve your problems.

"THE WORLD'S MOST COMPLETE CERAMIC SUPPLIER"

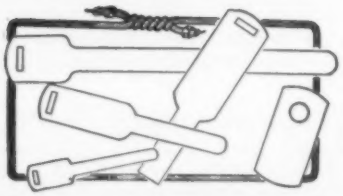
West Coast Warehouse, Laboratory and Office, 4747 E 49th Street, Los Angeles, California

TERMINAL TAGS

Identify Wires Permanently

Easy to apply, replaces obsolete string and paper identification methods. Can be specially stamp-coded or marked.

- **Aluminum, steel, brass, or zinc.**
- **Big variety, all styles and sizes.**
- **For aircraft, radio, telephone, motor and generator manufacture, etc.**



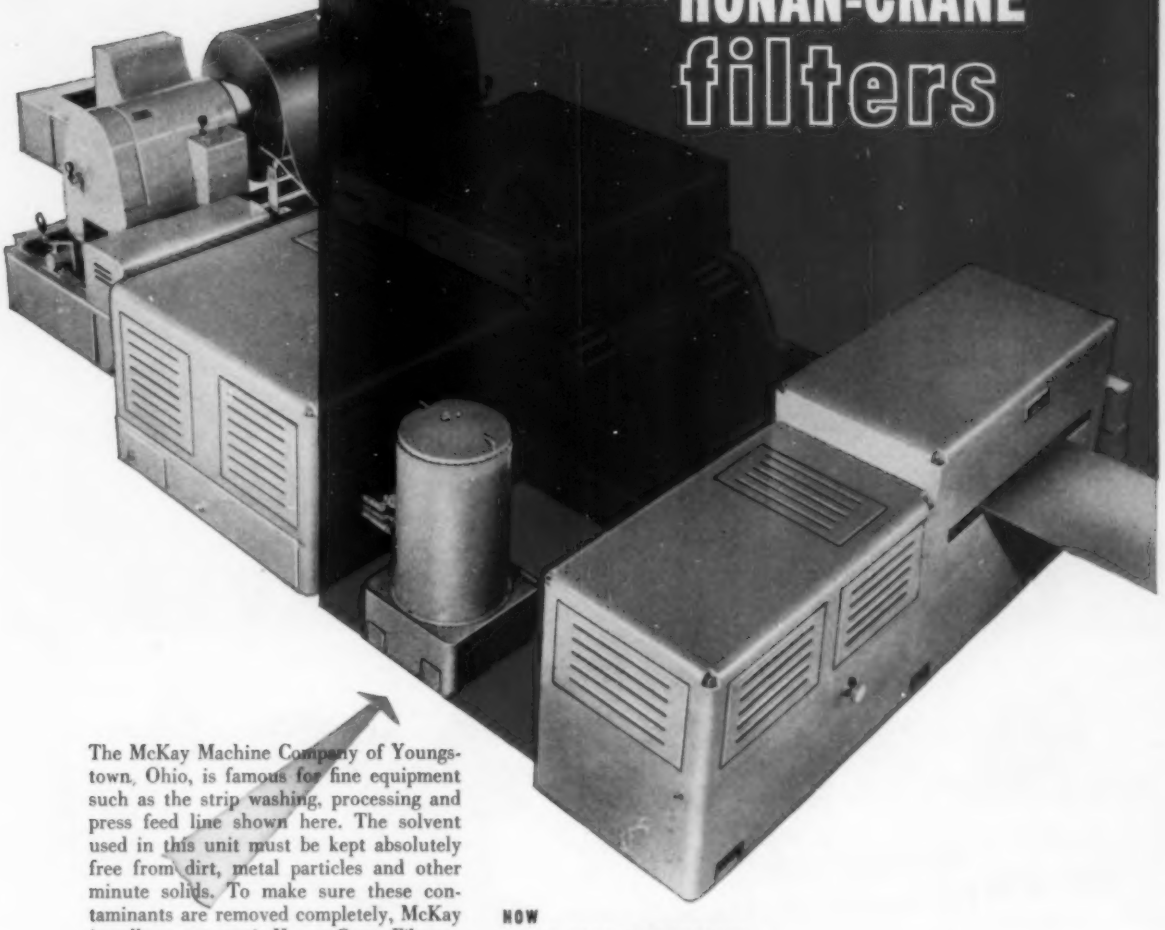
Free Samples and Literature Upon Request

NATIONAL BAND & TAG CO., Dept. 9-850, Newport, Ky.

right from the start...

McKAY COIL FEED LINES

EQUIPPED WITH **HONAN-CRANE filters**



The McKay Machine Company of Youngstown, Ohio, is famous for fine equipment such as the strip washing, processing and press feed line shown here. The solvent used in this unit must be kept absolutely free from dirt, metal particles and other minute solids. To make sure these contaminants are removed completely, McKay installs an automatic Honan-Crane Filter as *standard equipment* on every strip washing machine it makes. Honan-Crane Filters are also standard on Flex-Roll Processors and other McKay units.

McKay tells us that Honan-Crane was adopted only after on-the-job comparison tests among several leading makes of filters.

To gain a reputation for quality such as McKay enjoys you have to set your standards high. That's why we feel that McKay's decision to standardize with Honan-Crane Filters is a significant testimonial to Honan-Crane's superior performance.

NOW
HONAN-CRANE CAN IMPROVE
THE EFFICIENCY OF YOUR PRODUCT

Honan-Crane Filters keep oils, coolants and other liquids *cleaner*. They rid engines of contaminants that form dangerous sludge deposits . . . provide better product finishes with fewer rejects . . . save thousands of dollars annually in maintenance and oil replacement costs.

There's a Honan-Crane unit—large, small or in-between—for original or accessory equipment on engines, hydraulic units, machine tools, vacuum pumps, etc. Sales engineers in principal U. S. and Canadian cities are at your service.

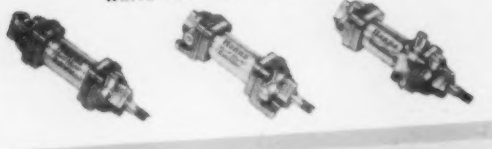
HONAN-CRANE CORPORATION
SHANNON, INDIANA
a subsidiary of
HOUDAILLE-HERSHEY CORPORATION

Choose the finest...for all your Fluid Power Jobs!

Hanna Fluid Power 750 SERIES

The newest in the Hanna line. For Air operation up to 250 psi and Hydraulic operation up to 750 psi. They have many new construction and operating features. Standard mountings for every application.

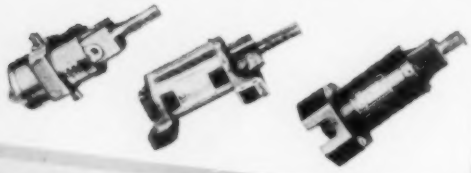
WRITE FOR CATALOG No. 750



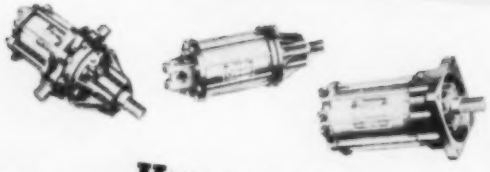
Hanna HP Hydraulic Cylinders

Selected for years, by industry around the world, for their smooth, rugged, dependable performance. Operating pressure up to 1500 psi. Sizes and mounting styles for most every need.

WRITE FOR CATALOG No. 233A



Hanna CYLINDERS and VALVES



Hanna LP Air & Hydraulic Cylinders

For low pressure operation up to 250 psi. In thousands of varied applications Hanna LP Cylinders have proved the fine quality and reliable performance Hanna builds into them. Standard mountings and a broad capacity range will handle most all low pressure fluid power problems.

WRITE FOR CATALOG No. 236

Hanna Air & Hydraulic Valves

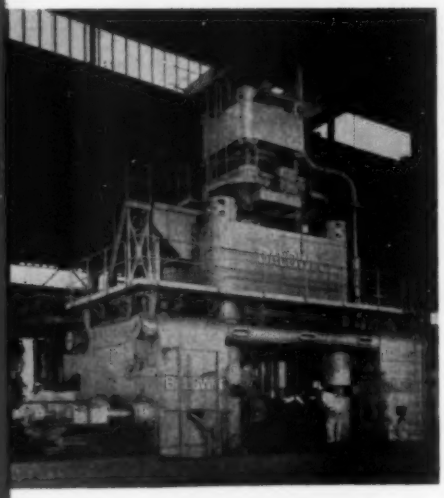
Designed to provide most efficient control for Hanna cylinders — ideal for other fine control jobs too. Many types available for hand, foot and electric operation, speed control, pilots and master for automatic and remote control.

WRITE FOR CATALOG No. 254

Check your Classified Telephone Directory for the Name of your Hanna Sales Representative

Hanna Engineering Works

1763 ELSTON AVENUE • CHICAGO 22, ILLINOIS



These propeller blanks were forged on Cameron's 26,000 ton multiple ram split-die ferrous metal forging press.

ANOTHER LARGE SIZE AND INTRICATE SHAPE IS FORGED

Pictured above are 64" aircraft propeller blanks now being forged from steel, rough machined and cold pressed at Cameron Iron Works, Houston. These forgings, free of inclusions and crevices, are then drawn and shaped by the prime contractor into propeller blades.

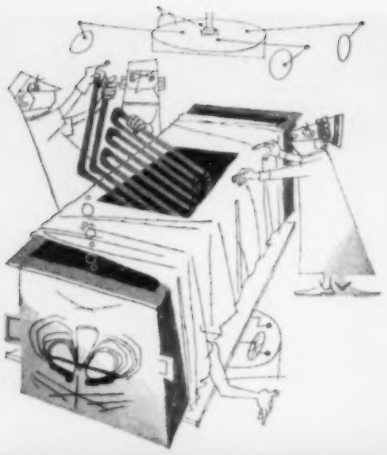
You too may have the need for forgings which will result in improved quality products at lower manufacturing costs.

FORGE AND ORDNANCE DIVISION

Cameron

IRON WORKS, INC.
HOUSTON, TEXAS

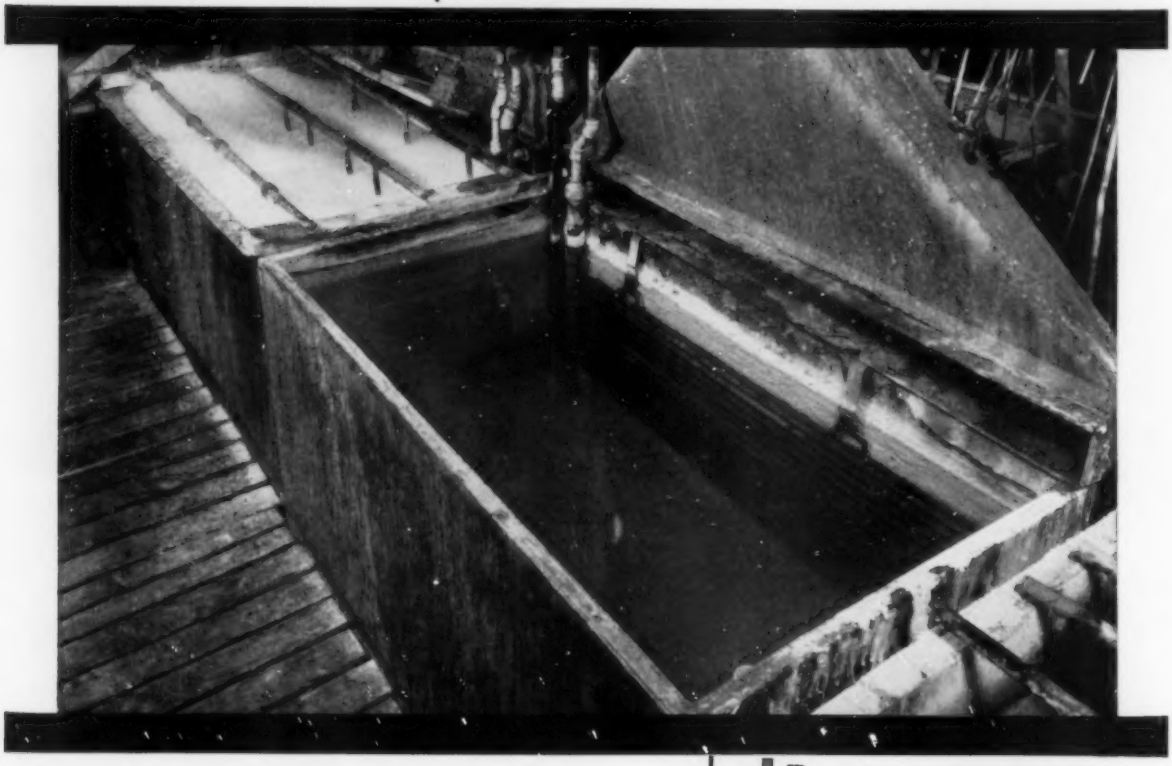
Write today for further information.



maintenance costs cut in half as

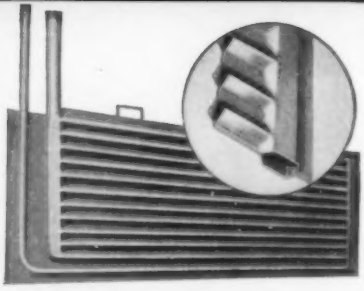
PLATECOILS *cure coil-itis* *

Addressograph - Multigraph Corporation has considerably reduced their process heating costs by changing to Platecoils instead of serpentine pipe coils for such processes as alkaline stripping, alkaline cleaning and chemical blackening of steel. Addressograph saved through lower initial costs, lower installation costs and a 50% reduction in maintenance costs. Much less space is consumed by the Platecoils and heating efficiency is greatly increased.



PLATECOILS *replace pipe coils for 50% of the cost*

* Coil-itis is the constant doctoring of wet processing tanks for pipe coil troubles. It can be cured easily by replacing pipe coils with Platecoils. Immediately, you will notice the difference as Platecoils put new life and profits into your heat transfer processes. They heat or cool 50% faster and take 50% less space in the tank. They save as much as 50% in initial cost and 50% in maintenance costs in addition to overcoming the limitations and operating difficulties of old fashioned and outmoded pipe coils.



Bulletin P77 shows how Platecoils are replacing pipe coils at a savings throughout industry. Send today for your copy.

Platecoil Division, TRANTER MANUFACTURING, inc., Lansing 4, Michigan

For fast shipment see your local distributor

looking

for a finish to

withstand

corrosion?

abrasion?

high heat?

Porcelain Enamel

is your wisest choice!

These three enemies of *long product life* can be stopped before they start by using Porcelain Enamel! In a wide variety of industrial and consumer products this modern, 100% inorganic material provides effective resistance to corrosion, abrasion and high temperature, thereby improving the product and adding to its *salability!*

- Where corrosive conditions exist as in industrial piping and tanks for storage or processing, or in jet engine liners, or farm equipment, this glass-hard, steel-strong, non-porous material serves well.
- For bearings, or chutes, or other materials handling equipment, its hard, smooth surface resists abrasion and wear.
- Temperatures up to 1700° F. and even higher are within the working range of recently developed Porcelain Enamels.
- Even where destructive forces attack in combination —high temperature *and* corrosive conditions *and* abrasion—properly designed Porcelain Enameled products have amazing life.

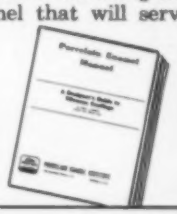
ADDS SALABILITY

An extremely valuable feature of Porcelain Enamel is the opportunity it offers to add the eye-appeal of attractive appearance. Porcelain Enamel gives you wide latitude in the use of color, design and texture. Thus greater salability is achieved through better design, better performance and more attractive appearance with Porcelain Enamel!

We will be happy to work with you in selecting the type and grade of Porcelain Enamel that will serve you best.

SEND FOR DESIGN MANUAL

To guide manufacturers in the most effective use of this modern engineering material, we will be glad to send a free copy of the Porcelain Enamel Design Manual. It contains factual data and useful suggestions.



Lifetime PORCELAIN ENAMEL

PORCELAIN ENAMEL INSTITUTE, INC.

PORCELAIN ENAMEL INSTITUTE, INC.

1346 Connecticut Ave. N.W. • Washington 6, D.C.

PORCELAIN ENAMEL INSTITUTE, INC. PE 5
1346 Connecticut Ave., N. W.
Washington 6, D. C.

Please send a free copy of your Engineering Design Manual to:

NAME_____ Position_____

COMPANY_____

ADDRESS_____

An Announcement of Importance to Everyone in the Engineering Field
SEALMASTER'S New
Rubber Mounted · Zone Hardened
BALL BEARING UNITS
REDUCE NOISE, VIBRATION AND WEAR!
Here's new proof that the real advances in design and engineering come from SEALMASTER! This new Rubber Mounted, Zone Hardened Ball Bearing Unit — another SEALMASTER patented exclusive — is now in full production.
A-2055
CARTRIDGE UNIT
FLANGE UNIT
SEALMASTER
BALL BEARING UNITS
Any manufacturer interested in quieter operation and smoother performance for his product will find the answer in this new bearing unit. Designed to reduce noise and vibration — a Zone Hardened SEALMASTER Ball Bearing Unit is mounted in a synthetic, oil-resistant rubber ring which fits snugly into a pressed steel housing — pillow block or flange type. Cartridge units are also available for insertion in special and built-in housings. Whether your product is on the drawing board or the production line, you'll want further information about the features of this new bearing unit.
Bulletin 1253 gives full information on the SEALMASTER Rubber Mounted line. Write for it today!
SEALMASTER BEARINGS A DIVISION OF STEPHENS-ADAMSON MFG. CO. • 9 RIDGEWAY AVE., AURORA, ILL.

SAFEGUARDING INDUSTRY'S *Lifelines of Mobile Power*

190 HORSEPOWER "led to work" through Eastman *first in the field*

HYDRAULIC HOSE ASSEMBLIES

enables the Jeffrey COLMOL to mine 3 to 5 tons of coal per minute

Every movement and adjustment performed hydraulically

- Drives arms that mine the coal.
- Forward, back—right or left.
- Raising, lowering cutting head.
- Tilting heads to follow veins.
- Separating heads for higher cut.
- Raising discharge conveyor.

The mechanical marvel shown in operation here . . . the 76-B Jeffrey COLMOL . . . is indeed a "mighty mole," capable of tunneling into a coal vein at a speed of two feet, or more, per minute—delivering from 50 to 100 tons of coal per man day.

Every movement and adjustment is hydraulically controlled through Eastman Hydraulic Hose Assemblies. Over 2000 psi is applied through 1¼" Eastman double braided hose, delivering 140 hp to 10 coal cutters which rotate at 50 rpm against the coal seam. Another 50 hp is independently provided for other hydraulic operations. Marvelous mobility is evidenced by the fact that this 25 foot, 35 ton monster can turn around in its own length.

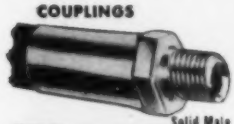
The Jeffrey Mfg. Co., pioneers in the coal mining equipment field, have used Eastman Hydraulic Hose Assemblies on all their machines for over 20 years. Eastman Manufacturing Company, pioneer in its own field, too—is proud to have played a part in the development of the Jeffrey line.

Call upon our 25 years of experience in the application of mobile hydraulic power . . . for greater efficiency in power transmission, lowest cost power delivery and most satisfactory performance. Engineering consultation at your call.

Specify Eastman *first in the field* **HYDRAULIC HOSE ASSEMBLIES**

for the best performance, for long life and satisfaction—*all along the line*—from manufacturer to user. Check your needs on the following list:

COUPLINGS



Solid Male

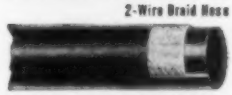
Swivel Male

Swivel Female

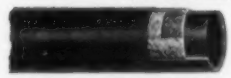
HOSE

1-Wire Braid Hose

2-Wire Braid Hose



1-Fabric Braid Hose



2-Fabric Braid Hose

Spiral Wire Hose

Write for free catalog 101 on Eastman hose couplings and fittings.

Eastman

MANUFACTURING COMPANY

Since 1914

Dept. PE-9, Manitowoc, Wisconsin

NEW AEROQUIP SOCKETLESS FITTINGS

make hose line replacement *amazingly easy . . . amazingly quick!*

Imagine making Aeroquip hose assemblies by just *pushing* socketless fittings into the hose! Hand pressure does it, and the fittings stay on for keeps thanks to unique design features.

With no socket, Aeroquip socketless fittings are the last word in one-piece simplicity. They are specifically designed to work with Aeroquip 1525 triple-ply, cotton-reinforced hose.

A small inventory of bulk stock makes fuel, air, water, and oil lines using medium pressures. There is no waste or dead inventory. Sizes available are ¼, ⅜, ½, and ⅝". For more information call your Aeroquip distributor or write us direct.

Just Push Them On!
. . . They'll Stay On!

Aeroquip

REG. TRADE MARK

AEROQUIP CORPORATION, JACKSON, MICHIGAN

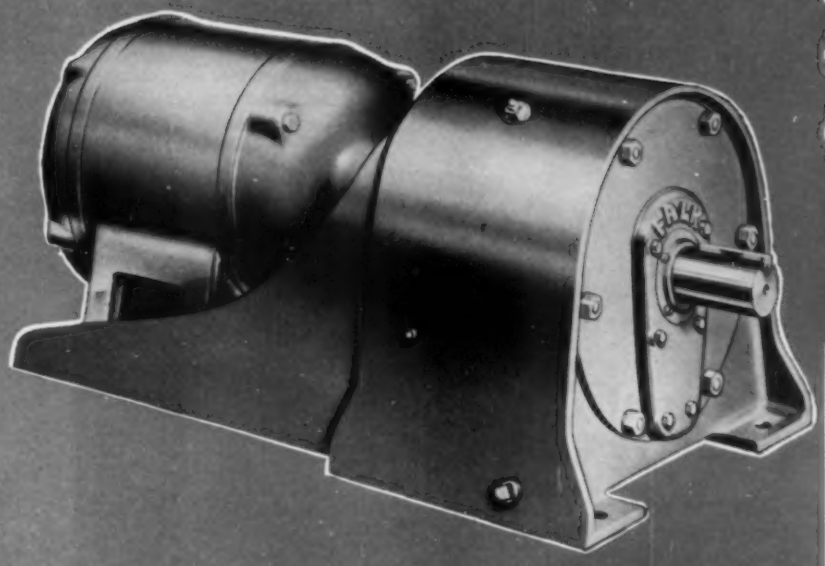
SALES OFFICES: Burbank, Calif. • Dayton, Ohio • Hagerstown, Md. • High Point, N. C. • Miami Springs, Fla. • Minneapolis, Minn. Portland, Ore. • Van Wert, Ohio • Wichita, Kan. • **IN CANADA:** Prenco Progress and Engineering Corporation Ltd., Toronto

AEROQUIP PRODUCTS ARE FULLY PROTECTED BY PATENTS IN U.S.A. AND ABROAD

Choose the All-Motor type,

ALL-STEEL FALK Motoreducer

...with complete foot-mounted motor of ANY make ANY type ANY speed



Its exclusive, superior features mean LONG-RANGE ECONOMY!

The FALK all-steel, All-Motor type Motoreducer provides superior features and advantages found in no other reduction unit. Here is the only compact motorized reducer with a separate foot-mounted, resilient Steelflex coupling-connected, standard motor *without modifications!* It accommodates *any* make, type, or speed of motor within the AGMA rating of the unit.

The simplified construction of the FALK All-Motor type Motoreducer means real long-range economy. The assembly is highly versatile; it permits the use of special purpose couplings, brakes, fluid drives or other adaptations without modification of reducer or motor other than the addition of the special features. Standard motors from manufacturers' field stocks are always available without costly delivery delays or special motor or shaft modification.

When you choose a FALK All-Motor type Motoreducer, you get the utmost in design and dependability of performance—plus the greatest possible dollar-for-dollar value throughout its traditionally long life . . . Available in standard ratios for stock shipment. Write for Bulletin 3104.

FALK ...a good name in industry

THE FALK CORPORATION 3001 W. Canal St. Milwaukee 8, Wis.

Every FALK motoreducer has these "IN-BUILT" FACTORS

1 **All-steel Housings.** Unbreakable, strong, rigid. Generous overhung load capacities provided by wide bearing spans, large shafts and bearings.

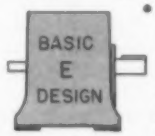
2 **Streamlined inside and outside.** Smooth, clean surfaces; machine welded construction conforms to NEMA motor frames.

3 **Sealed Housings.** Dual closures and one-way vents keep oil *in*, dust and moisture *out*. Units are splashproof, leakproof, dustproof.

4 **Positive Lubrication.** Large sump capacity ...oil-tight construction assures clean lubricant...direct dip of revolving elements provides positive lubrication at all speeds.

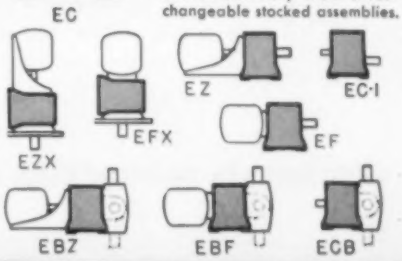
5 **Wide Speed Range.** Selective ratio combinations provide output speeds from 1.5 rpm to 1430 rpm with stock gears.

6 **Precision Gearing.** Heat-treated alloy steel, precision cut and shaved helical gearing throughout...quiet-operating crown shaved pinions...taper bored gears for easy ratio changes.



EC

The basic E design permits maximum use of standardized parts . . . closer control over materials, processing, inspection and assembly . . . resulting in faster delivery from interchangeable stocked assemblies.



WRITE FOR BULLETIN 3104

How Cindus X-CREPE® outperforms "traditional" burlap* in furniture roll edging

*If you use burlap or comparable material in any way (including bale wrap), it will pay you to look into the characteristics and advantages of Cindus X-Crepe, the new basic material.

X-Crepe stabilizes materials costs, helps slash installation time 90%

Burlap—traditional material of many uses—has been replaced by Cindus X-Crepe in roll edging, a furniture component made by Flex-o-lators, Inc., Carthage, Mo. X-Crepe outperforms burlap, gives these important advantages:

Stabilized materials costs—Eliminates jumpy, undependable burlap prices from their cost structure.

Makes roll edging easier to use—Now Flex-o-lators' roll edging can be bent sharply into neat, square corners *without mitering*—or can be smoothly "crimped" for curved chairs, modern sectionals and the like. Far simpler than previous methods.

Slashes user's installation time 90%, gives Flex-o-lators big sales advantage—X-Crepe accepts wire hog rings, eliminates hand sewing, gives user's furniture neat, tailored edges with greatly reduced labor costs—now one of Flex-o-lators' biggest competitive sales points.

Makes product tougher, practically indestructible—In an endurance test, 1,350,560 brutal poundings *broke a steel spring*, but left attached X-Crepe roll edging unharmed! It showed no wear and had not slipped or torn away from its original position.

Let us know your materials problem. Our research staff can work wonders at tailoring X-Crepe to suit your exact needs. We'll help you improve your product and reduce its cost.

Flex-o-lators reports X-Crepe simplifies fabrication, chops hours from production schedules. Unlike burlap, X-Crepe can be fed from continuous rolls, easily slit and sewn—makes whole operation speedier, more automatic.

X-Crepe's unusual formability, extra strength, built-in "give", resistance to tearing, all around toughness, make it ideal as a replacement for burlap. For many applications it can also replace materials like cork, rubber, felt and other kinds of cloth—almost always at a considerable cost saving!

In addition, X-Crepe can be impregnated, coated, laminated, made waterproof, combined with cloth and fibers, films and foils to extend the use of such materials far beyond their usual limits.

Write today for your Free Cindus Design Engineer's Portfolio, containing samples and complete information. Fits conveniently in your files.

cindus TRADE MARK

®X-CREPE is the trademark of Cincinnati Industries Inc. for its double-crepe products.

CINCINNATI INDUSTRIES INC. 362 CARTHAGE AVE., CINCINNATI 15, (LOCKLAND) OHIO

CUT COSTS

with the Original Mead

MIDGET AIR CLAMP

(Spring Return Air Cylinder)

In assembly jigs and other multiple applications, this new, low cost pressure unit saves countless man-hours. As a work-ejector in many fixtures, it is unexcelled.

Only $3.95 EITHER STYLE ($40.80 Per Dozen)

Advantages over mechanical clamps

1 **All Air Clamps** in any set-up can be operated by a single master valve—the "lock-up" and release of assemblies is instantaneous.

2 **May be installed in cramped corners** difficult to reach with bulky mechanical clamps. Mead Midget is the most compact air cylinder, for its power, on the market.

3 **Equal ram pressure at any point** along stroke, making special, delicate adjustments unnecessary.

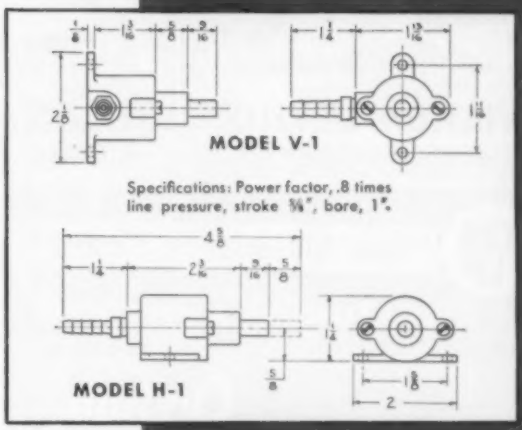
4 **Independent group control.** Any desired group of "Midgets" can be controlled independently of any other group in an assembly—as where primary members of the fixture must be locked up before the secondary members.

5 **Facilitates delicate drill operations.** Air Clamps actuated by foot control valves leave operator's hands free to handle the work pieces.

Send for all the interesting facts on these time-tested, superior Midget Air Clamps.

MEAD SPECIALTIES COMPANY

4114 North Knox Avenue • Dept. PE-94 • Chicago 41, Illinois



IMMEDIATE DELIVERY

Single-acting cylinders delivered from stock; double-acting in a few days.

Tear Out MEMO Coupon Now For

New MEAD INDUSTRIAL AIR POWER CATALOG

Full of suggestions for better, faster production with famous MEAD AIR-POWERED Collectors, Valves, Presses, Jigs, Chucks, Hammers, Drill Press Feeds, Work Fenders, semi-automatic control systems etc. Send today!

Memo Coupon

MEAD SPECIALTIES CO.

4114 N. Knox Ave., DEPT. PE-94, Chicago 41, Ill.
Send free copy of new, colored MEAD INDUSTRIAL AIR POWER CATALOG describing the complete line of famous Mead air-operated devices.

Name_____

Company_____

Address_____

City_____ Zone____ State____

AUTOMATIC RIVETING!

CHOBERT High-Speed System

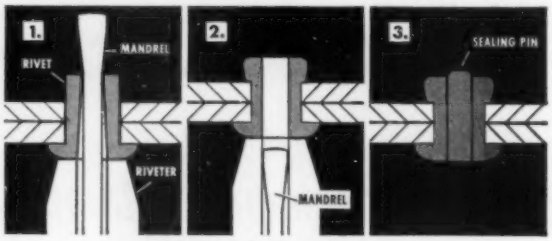
INCREASES PRODUCTION — CUTS COSTS!

FOR ALL BLIND OR OPEN RIVETING • NO SKILLED HELP REQUIRED • FULLY AUTOMATIC • UNIFORM RIVET RESULTS

The CHOBERT High-Speed Riveting System is especially designed for *fully-automatic blind or open riveting*. The pneumatic riveter can place rivets at a rate of 2000 per hour — solves blind rivet problems usually considered impossible with other riveting methods!

HERE'S HOW CHOBERT RIVETS WORK!

1. Insert rivet, automatically held ready by mandrel and jaws of Chobert pneumatic riveter, into proper size hole.
2. Press trigger of riveter. Mandrel draws back expanding rivet to uniform upset and tightness in one complete operation. Next rivet is automatically readied by Chobert Riveter for use.
3. Solid, finished rivet is gas and watertight. Can be used without sealing pin!



Meets Specification AF40911

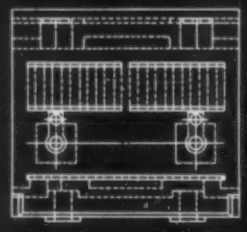
Manufacturer and Distributor of pip Self-locking, Quick-release Pins and avdel Positive-action Sheet Grippers.

AVIATION DEVELOPMENTS INC. 210 SO. VICTORY BLVD. • BURBANK, CALIFORNIA

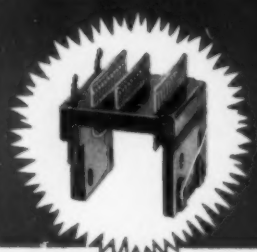
AVIATION DEVELOPMENTS (CANADA), LTD., TORONTO • AVIATION DEVELOPMENTS, LTD., LONDON, ENGLAND

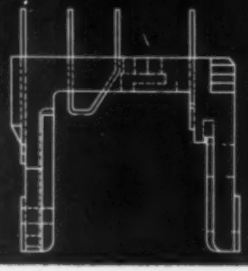
CMP "Your Blueprint In Plastics"

ALL MATERIALS • ALL PROCESSES



Custom Molding





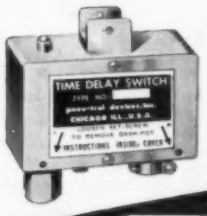
CONSOLIDATED

MOLDED PRODUCTS CORPORATION

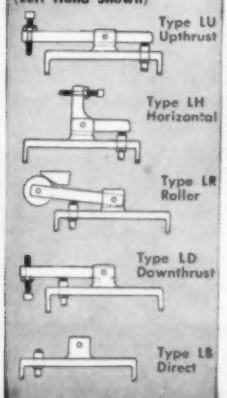
SCRANTON 2, PENNA.

NEW CYLINDER TIME DELAY CONTROL SWITCH

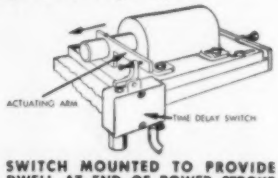
INCREASES APPLICATION . . . WIDENS USE OF CYLINDER POWER



For Any Type Actuation Left or Right Hand (Left Hand Shown)



Pneu-Trol Time Delay Switches provide independent hydraulically controlled adjustable time dwell between ¼ and 60 seconds in 20 to 1 ratios. Readily mounted on machine for cylinder dwell at a positive stop. Compactly designed—a simplified low cost answer to electrical time dwell control of any air or hydraulically operated machine movement such as press work, burnishing, coating, quenching, metal-cutting, etc. Ideal for automatic feeders. Dimensions: 4⅛" wide; 2¾" high; 1-7/16" deep. Overall height 4⅛".



SWITCH MOUNTED TO PROVIDE DWELL AT END OF POWER STROKE

Write for descriptive literature and complete details.

PNEU-TROL DEVICES, INC.

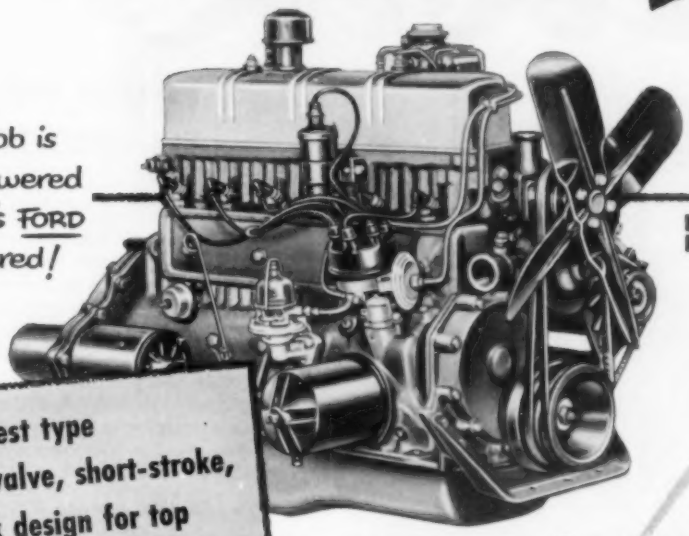
1430 N. Keating Ave. Chicago 51, Illinois

Introducing still another ULTRA-MODERN

FORD "223" CU. IN.

SIX-CYLINDER INDUSTRIAL ENGINE

at a Low FORD Price



Your job is WELL powered when it's FORD powered!

Ford INDUSTRIAL ENGINES AND POWER UNITS

It's the latest type overhead-valve, short-stroke, deep-block design for top performance and economy.

This new engine is designed to outperform other internal combustion power plants of comparable displacement on the market today. And, coupled with its gas-saving economy is the fact that parts and service are available through Ford Dealers everywhere.

Remember, too, that Ford Sales Engineers are always glad to discuss your particular power problems and extend every help in solving them. Merely phone or write us.

CHECK THESE OUTSTANDING FEATURES:

Overhead valves for better fuel economy, while "free-turn" action prolongs valve life.

Large bore, short-stroke design with 7.2 to 1 compression delivers more power from less displacement.

Chrome-plated top compression rings reduce both piston ring and cylinder bore wear to prolong engine life.

Full-flow oil filter cleans all the oil on every trip through the engine. Bearings last longer, engine life increased.

Full-length water jackets promote uniform expansion of cylinder walls.

Four-bearing, counterweighted crankshaft is precision-balanced for smoother engine operation.

Deep design of engine block extends well below center of crankshaft for greater rigidity, quiet performance and extra long engine life.

A detailed descriptive folder of the Ford "223" Engine, giving complete specifications, power and torque curves, dimensional drawings, accessories available for specific applications, etc., will be sent you upon request.

INDUSTRIAL ENGINE DEPARTMENT

FORD MOTOR COMPANY

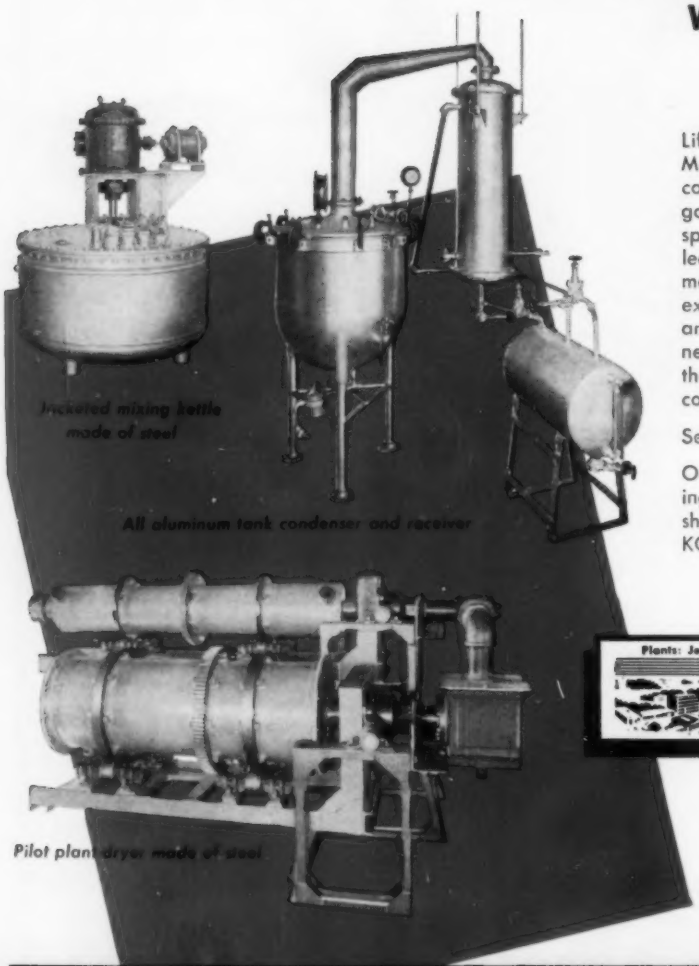
15050 Woodward Avenue, Highland Park 3, Michigan

BACK IN THE 1880's

WHEN MARK TWAIN CREATED "HUCKLEBERRY FINN"

Koven

WAS MAKING INDIVIDUALIZED EQUIPMENT PARTS



Jacketed mixing kettle made of steel

All aluminum tank condenser and receiver

Pilot plant dryer made of steel

Life on the Mississippi has changed since the days of Mark Twain — but "Huck" Finn's exciting adventures continue to thrill each new generation. Production goals have changed also and today — when efficient, speedy output is more important than ever — KOVEN's leadership in the field of special parts fabrication remains unchallenged. That's because KOVEN has the experience, skill and vast facilities necessary to design and manufacture individualized parts to your exact needs — usually more quickly and more economically than you could in your own plant. Call or write for a consultation — no obligation.

Send for Facilities Catalog # 490 and Brochure # 550.

Our complete modern facilities include: Machine, welding, plate and sheet metal, galvanizing and painting shops. X-ray equipment insures quality control in every KOVEN Individualized Equipment Part.

L. O. KOVEN & BRO., INC.

154-C Ogden Ave., Jersey City 7, N. J.

KOVEN FOR INDIVIDUALIZED EQUIPMENT SINCE 1881

WHICH "150" fits your oscillographic recording need?

4-CHANNEL

As a graphic example of the design idea that has brought new versatility to industrial recording, a Carrier Preamplifier (A) is shown above in position to plug into a Driver Amplifier in framework with Power Supply (B) which are normally already in place in the Basic Cabinet Assembly.

The identical design principles of the four-channel system are provided in the two-channel, the only difference being the number of channels.

Sanborn "150" Recording Systems that put to use the original design concept of amplifier interchangeability (illustrated at the left) start with either a four-channel or two-channel standard Basic Assembly, to which the user adds whatever selection or combination of pre-amplifiers (A) are needed for his recording problem. The standard Basic Assemblies comprise a metal Cabinet, Recorder, and a built-in Driver Amplifier and Power Supply (B) for EACH channel. Presently available Preamplifiers are: AC-DC, Carrier, DC Coupling, Servo Monitor, Log-Audio, and Low Level Chopper.

Advantages common to ALL Sanborn Recorders are: inkless recording (by heated stylus) on plastic coated strip chart paper, and in true rectangular coordinates . . . high torque galvanometer movement . . . time and code markers . . . numerous paper travel speeds.

2-CHANNEL

"150"

COMPLETE FOUR-CHANNEL SYSTEM FOR USE WITH ANALOG COMPUTERS

This "150" system consists of a Cabinet Assembly, a four-channel Recorder, and *two* dual channel DC Amplifiers. Each amplifier is complete with a common power supply. Each measures and records two separate single-ended signals, at sensitivities between one and one hundred volts per centimeter. The *two*-channel version of this system will comprise Cabinet, *two*-channel Recorder, and *one* dual channel amplifier.

"150"

SINGLE-CHANNEL RECORDER

A compact, lightweight unit for use when only one channel is required — provides permanent, inkless recording in *true* rectangular co-ordinates; *five* paper speeds (5, 10, 25, 50, 100 mm/sec.); *extra* stylus for either manual or remote timing and coding marks. Designed for simple, patch cord connection to *any* of the several "150" preamplifiers (plus driver amplifier and power supply), available soon in portable metal cases.

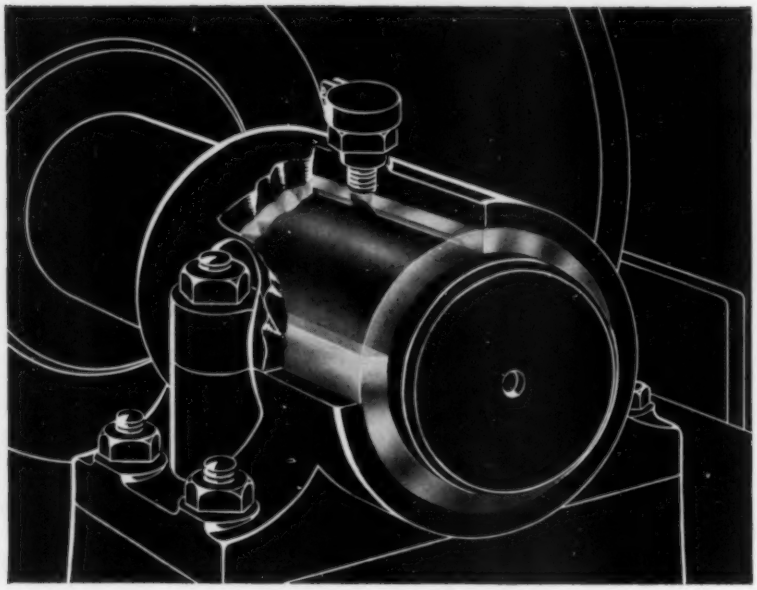
Ask, also, for a copy of the *Right Angle* — a Sanborn publication devoted to oscillographic recording in industry.

Catalog and technical data on all "150" equipment available on request.

SANBORN COMPANY

Industrial Division

CAMBRIDGE 39, MASS.



THE WAY TO CUT...

Cost of imitation

If you are using an expensive type of bearing because a competitor of yours uses it you are needlessly saddling expense onto your product if the job could be done as well or better with a less expensive type—as for example the cast bronze sleeve bearing.

Your customer buys your product because it does a job he needs done in the way he wants it done. Your company's name and reputation support your product, and the mere fact that you include unnecessarily expensive bearing types is not a factor in the sale. We suggest you examine your present designs to determine if there are not places where the sturdy, simple, cast bronze sleeve bearing can help you toward necessary cost reductions.

There is a Bunting Engineer near you. Consult him. Or write our Product Engineering Department at Toledo.

Bunting®

BRONZE BEARINGS • BUSHINGS • PRECISION BRONZE BARS

The Bunting Brass & Bronze Company • Toledo 1, Ohio • Branches in Principal Cities • Distributors Everywhere

Let this unique illustration convey to you the remarkable cooling effect of Howell's new internal ventilation system in Series 100 Motors.

New Howell re-rated motors run cooler... save space

Here are *completely new* motors . . . built with *your* design requirements in mind . . . smaller, lighter, cooler running, with generous overload capacity!

Now! Howell brings you everything you want in a re-rated motor: smaller size and lighter weight . . . plus *better cooling* for less maintenance and longer life.

Howell Series 100 re-rated motors feature a new internal ventilation system that provides 50% more contact between cooling air and active lamination materials. Temperature ratings are easily maintained; overload capacity is increased.

Many New Features

Series 100 Motors offer many other advantages: *They take up less space* – up to 30% less in some sizes; both open and totally enclosed fan-cooled motors have same diameters. *They perform better* – Howell uses dependable copper rotors for higher conductivity, greater flexibility; new Mylar* slot insulation is thinner (more space for copper windings), yet eight times stronger. *They last longer* – better cooling, double-shielded bearings and super tough steel frames and feet, with cast iron endplates, insure extra years of trouble-free performance. *They fit your special needs* – Howell provides rotors in three diameters for each frame size; corrosion-resistant materials and fittings are available to meet your specific industry problems.

Before you buy any re-rated motor, compare Howell Series 100 Motors for modern design, outstanding performance, and engineered precision. Howell will continue to make a complete line of regular and special motors – we have in our files more than 20,000 electrical design specifications! Let us serve you. Call your Howell man today.

*DuPont trade mark

HOWELL Red Band MOTORS

HOWELL MOTORS

Howell Electric Motors Company, Howell, Michigan

MOTORS FOR INDUSTRY SINCE 1915

Use CLEVE-WELD Process Welded Rings

—all ready for finish machining!

AS COMPARED with other methods, this roll-and-weld process is able to produce preshaped, accurately dimensioned blanks that often do away with all rough machining and the expense of much excess metal. These blanks are stronger, too, because they have continuous grain flow throughout. Since they're practically free of subsurface defects, rejection of nearly completed parts is virtually eliminated.

Blanks of rectangular cross section, such as ring gear blanks and motor or generator shells made by the Cleve-Weld Process, are rolled from plain bar steel, then welded.

Send for our 28-page brochure describing the Cleve-Weld Process and illustrating our special facilities for serving you. And be sure to check with us on your needs for steel blanks from 6 to 48 inches in diameter and up to 2½ inches in thickness. Write THE CLEVELAND WELDING COMPANY, West 117th Street & Berea Road, Cleveland 7, Ohio. (Subsidiary of American Machine & Foundry Company, New York).

The CLEVE-WELD Process
for lower-cost circular steel parts

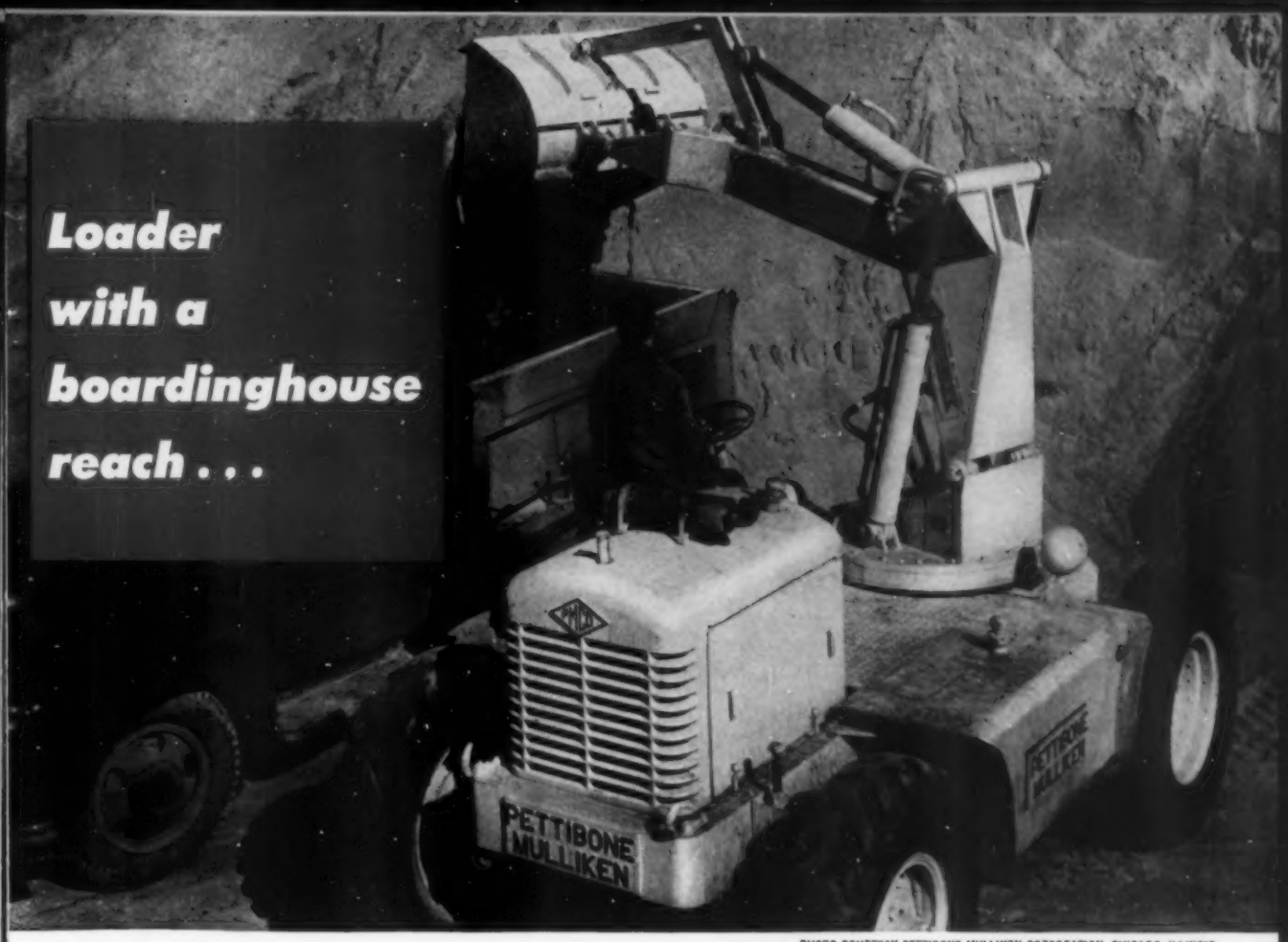


PHOTO COURTESY PETTIBONE MULLIKEN CORPORATION, CHICAGO, ILLINOIS

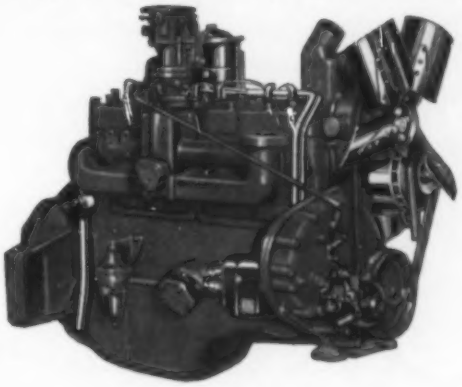
CHRYSLER *Industrial Engine and torque converter assure faster handling of tougher jobs*

This versatile, highly maneuverable loader goes after work like a stevedore after "seconds." Boom swings through 180°, loads faster, in less space, to the left or right without moving from its short, single working line. Cuts loading time up to 25%. Bucket, fork, tote hook and backfiller blade attachments are interchangeable.

Torque Converter provides extra power for tough going, faster acceleration *without* necessity of shifting gears or declutching. Furthermore, the Torque Converter eliminates shock loads to the power train . . . thus reduces maintenance.

Pettibone Mulliken Speed Swing Loaders come in two sizes . . . ¾ cubic yard and 1 cubic yard. Both sizes can be supplied with four-wheel drive (like the unit pictured), and four-wheel steer. Chrysler 230 cubic inches displacement Model 30 Industrial Engine drives the ¾ cubic yard unit, and the 265 cubic inches displacement Model Ind. 16 drives the 1 cubic yard unit. Chrysler Torque Converter connects engine with four-speed transmission, transmits power to boom.

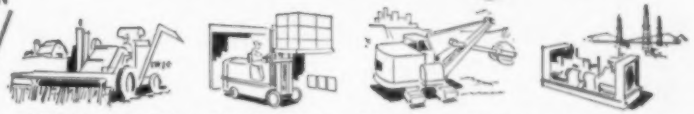
In considering power for your equipment, remember Chrysler Power is not expensive. Production-line methods adapted to specialized industrial engine building provide a custom-built engine at mass-production prices. See a Chrysler Industrial Engine dealer or write: ***Dept. 59, Industrial Engine Division, Chrysler Corporation, Trenton, Mich.***



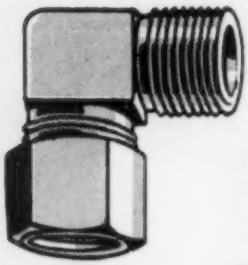
CHRYSLER *Industrial Engines*

INDUSTRIAL ENGINE DIVISION • CHRYSLER CORPORATION

HORSEPOWER WITH A PEDIGREE



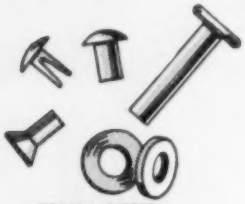
AGRICULTURE • INDUSTRY • CONSTRUCTION • OIL FIELDS



INDUSTRIAL and AUTOMOTIVE FITTINGS

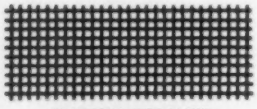
COPPER NAILS and TACKS
BRASS LAG and CAP SCREWS

BRASS or BRONZE BOLTS and NUTS

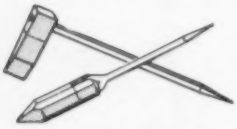


BRASS or COPPER RIVETS and WASHERS

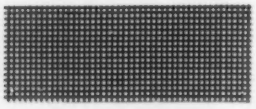
BRASS, COPPER, BRONZE COTTER PINS



INDUSTRIAL WIRE CLOTH



SOLDERING COPPERS



BRASS STRAINER CLOTH

COPPER ANODES

BRASS or BRONZE WOOD and MACHINE SCREWS

BRASS ESCUTCHEON PINS

SOLID or CORED BEARING BRONZE

CHASE NOW SELLS STAINLESS STEEL, TOO!

Need anything here?

Chase *has* it–in wide variety. You can be sure of getting fast service and the finest in brass and copper miscellaneous items–when you call Chase. Your nearest Chase Warehouse is listed below.

Chase®

BRASS & COPPER CO.

WATERBURY 20, CONNECTICUT • SUBSIDIARY OF KENNECOTT COPPER CORPORATION

FREE CHASE MOVIE

See "The Science of Making Brass," prize-winning documentary film. Now available on request to metal-working industries, technical associations, schools. Write any Chase office listed below.

The Nation's Headquarters for Brass & Copper

Albany†	Chicago	Denver†	Kansas City, Mo.	Newark	Pittsburgh	San Francisco
Atlanta	Cincinnati	Detroit	Los Angeles	New Orleans	Providence	Seattle
Baltimore	Cleveland	Houston	Milwaukee	New York	Rochester†	Waterbury
Boston	Dallas	Indianapolis	Minneapolis	Philadelphia	St. Louis	(†sales office only)

For Rugged Power Uses Exclusively

4 MODELS
4 and 6 CYLINDERS
.403 TO .559 Hp / CU. IN. DISPL.

"JOHN" WILLYS *

Engine Chalk Talk

I wanted to be one of the first to let you know that we at Willys have designed four POWER GIANT Engines just for industrial uses. They're based on proven designs . . . with "proven-in-action" features known for ruggedness from the Arctic to the Tropics. And, they incorporate the same low maintenance, high efficiency characteristics of all Willys designs. As for torque and power, the POWER GIANTS are right up top in their weight and displacement class. For rugged power needs, investigate these POWER GIANTS.

* Design Department, Willys Motors, Inc.

Willys **POWER GIANT** Industrial Engines and Power Units

INDUSTRIAL ENGINES and POWER UNITS

Model	Cyl. and Head	Displ. Cu. in.	Range Max. bhp	Range of speed
Jeep	4 L	134.2	22 - 60	1200 - 4000
Hurricane	4 F	134.2	22 - 70	1200 - 4000
Lightning	6 L	161.0	28 - 75	1200 - 4000
Giant Hurricane	6 F	161.0	28 - 90	1200 - 4200

SEND FOR POWER GIANT BULLETINS
4 Cylinder Engines
6 Cylinder Engines
Power Units

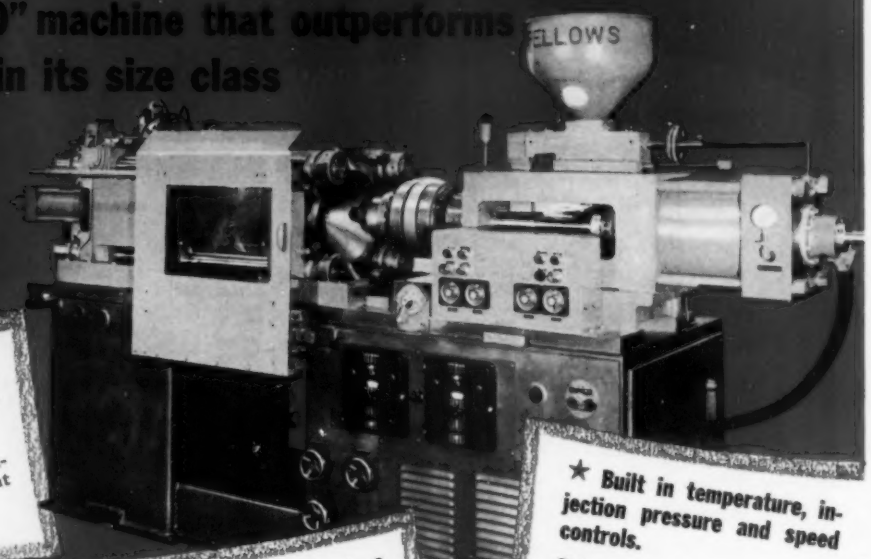
PROVEN IN ACTION

WILLYS MOTORS, INC. Industrial Engine Department

FELLOWS LEADS AGAIN...

NEW Full 6 ounce

...the "6-200" machine that outperforms anything in its size class



★ **Takes 12″ x 24″ molds horizontal, or 15″ x 21″ vertical, 8″ to 14″ thick!**

Molds open 6 to 9 inches; convenient clamping adjustment from single control.

★ **Entire press hydraulically retracts from nozzle for purging!**

Easy set-up! Open space on all four sides of die platens for auxiliary cylinders, hoses and conveyors.

★ **New, improved Speed-Flo heating cylinder!**

Highly efficient heat transfer. Optional Dual Pressure Control of injection affords lower adjustable "holding" pressure.

★ **Full Automatic Operation!**

Extra equipment provides counter, air-blast connections, alarm timer and mold-safety-device.

★ **Variable stroke adjustment and rapid advance injection.**

'Dry-run' speeds from 490 to 650 cycles per hour. Up to full 6 ounce shot of styrene with 20,000# injection pressure. 40% more material with optional 'pre-pac' device.

★ **Built in temperature, injection pressure and speed controls.**

Shipped ready to go to work. Needs only power, water supply and drain connections.

★ **Extra safety!**

Hydraulic and electric interlocks on safety doors. Power shuts off automatically if electrical compartment door is opened. All hydraulics externally mounted for safe accessibility.

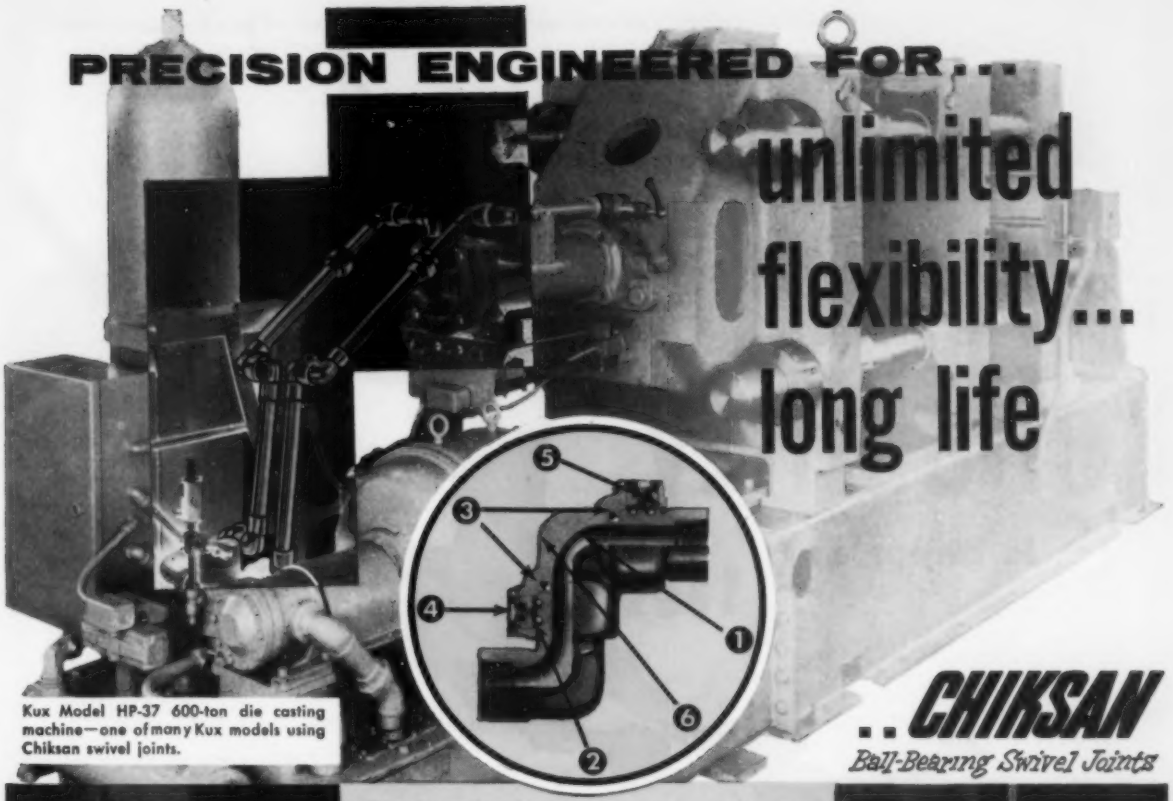
Investigate!

Fellows injection molding equipment

THE FELLOWS GEAR SHAPER COMPANY, Plastics Machine Division, Head Office and Export Department, Springfield, Vermont
Branch Offices: 319 Fisher Bldg., Detroit 2, Michigan • 5835 West North Avenue, Chicago 39, Illinois • 2206 Empire State Bldg., New York 1, N. Y.

PRECISION ENGINEERED FOR...

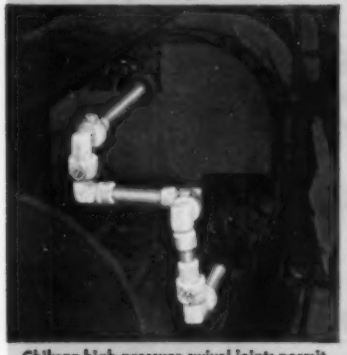
unlimited flexibility... long life



Kux Model HP-37 600-ton die casting machine—one of many Kux models using Chiksan swivel joints.

..CHIKSAN
Ball-Bearing Swivel Joints

Johnson Motors cut fluid losses 75%—setting-up time 75% with Chiksan joints on their 48 die-casting machines.



Chiksan high-pressure swivel joints permit compact assembly for operation in limited space on injection molding equipment.

1. Smooth flow radii for minimum flow restriction.
2. 2 rows of ball bearings handle thrust and radial loads.
3. Balanced packing units for specific services.
4. Spherical radius ball plug for uninterrupted ball race.
5. Grease retainer provides extra protection for ball race area.
6. Wall thicknesses provide maximum strength throughout.

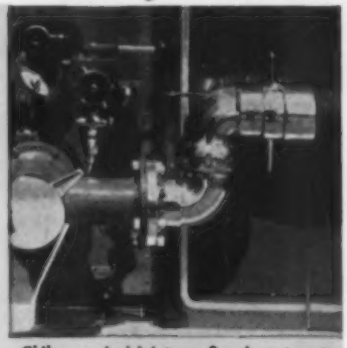
CHIKSAN Ball Bearing Swivel Joints turn with full 360° rotation in 1, 2, and 3 planes, handling air, hydraulics, fuels, oils, water and other fluids.

There are over 1,000 different types, styles and sizes for pressures and services from 28" vacuum to 15,000 psi and for temperature ranges from minus 75° F. to a plus 500° F. Packing materials have been designed for each specific service.

Wherever unlimited flexibility is required in your research, design and engineering of new equipment for modern industry—CHIKSAN will help you find the solution.

Write for complete information. Dept. 9-PE

The Flow of Enterprise Relies on
CHIKSAN
Ball-Bearing Swivel Joints



Chiksan swivel joints on fire department trucks provide increased hose flexibility and save on hose wear.

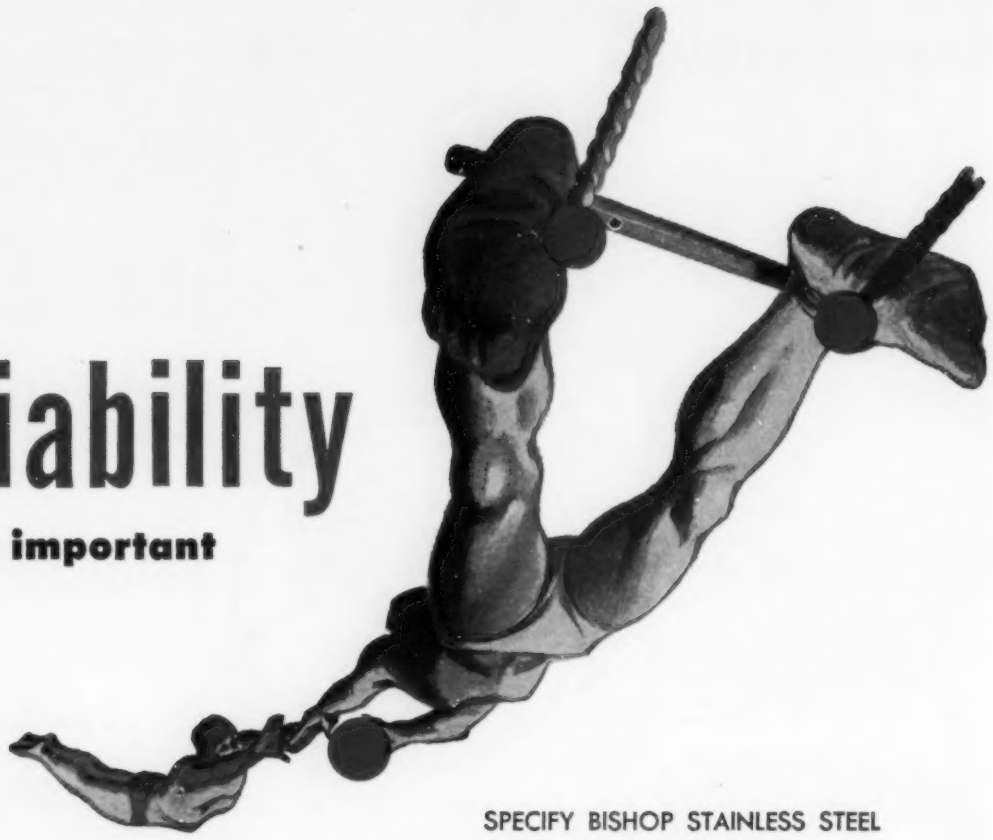
Chiksan high-pressure swivel joints provide flexibility and eliminate danger of ruptured steam lines on platen presses.

CHIKSAN COMPANY • BREA, CALIFORNIA • Chicago 3, Illinois • Newark 2, New Jersey

Well Equipment Mfg. Corp. (Division), Houston 1, Texas • Subsidiaries: Chiksan Export Co., Brea, Calif., Newark 2, N. J. • Chiksan of Canada Ltd., Edmonton, Alta.

Reliability

is important



SPECIFY BISHOP STAINLESS STEEL TUBING (.008" TO 1" O.D.)

The in-use success of your product or manufacturing process depends upon reliable components. And reliable components are the result of vigilance and attention to detail.

Bishop, the first American company to draw small diameter stainless steel tubing, assures this reliability in each length of stainless steel tubing by continuous inspection methods, both visual and mechanical, at each step of the operation.

When dimensional accuracy and metallurgical uniformity is important, specify Bishop stainless steel tubing and be sure. Catalog on request.

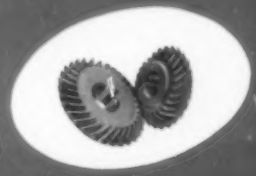
If you buy stainless steel fabricated tubular parts, or fabricate parts yourself from stainless steel, investigate Bishop's cost-reducing "under one roof" drawing and fabricating facilities. You'll save more.

You are cordially invited to visit our booth, No. 917-919, at the Instrument Show, Philadelphia, Sept. 14-24.

J. BISHOP & CO. PLATINUM WORKS

Stainless Steel Division • Malvern, Pennsylvania

Platinum and Platinum group metals
Spinnerettes
Medical Products
Small Diameter Stainless Steel Tubing
Fabricated Tubular Parts



"The Lowest Bidder

It's unwise to pay too much, but it's worse to pay too little. When you pay too much, you lose a little money—that is all.

When you pay too little, you sometimes lose everything, because the thing you bought was incapable of doing the thing it was bought to do. The common law of business balance prohibits paying a little and getting a lot—it can't be done. If you deal with the lowest bidder, it is well to add something for the risk you run. And if you do that, you will have enough to pay for something better."

John Ruskin

1819-1900

Especially true of Gears

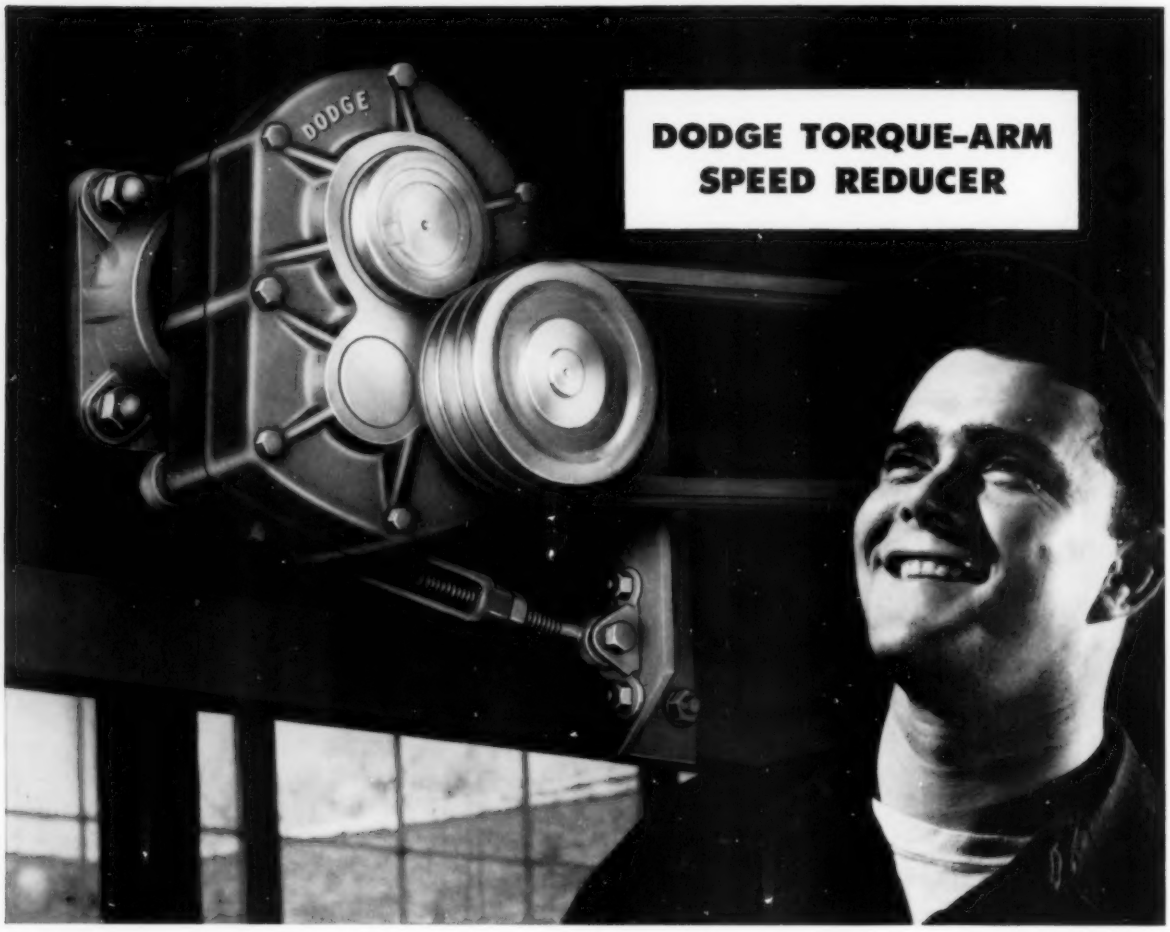
DOUBLE DIAMOND GEARS

FOR AUTOMOTIVE, FARM EQUIPMENT AND GENERAL INDUSTRIAL APPLICATIONS
GEAR-MAKERS TO LEADING MANUFACTURERS

Automotive Gear Works, inc.

ESTABLISHED IN 1914

RICHMOND, INDIANA



Costs less - Delivers more!

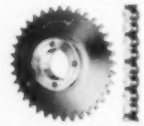
Savings up to 33% . . . efficiency up to 97% . . . are yours with this new and better kind of speed reducer. Proved in tens of thousands of installations, in all types of industry!

This reducer is mounted directly on the driven shaft. No foundation, no flexible couplings, no sliding base required. No lining up difficulties. The torque-arm, fastened to any fixed object, anchors the reducer. Unit is driven through any V-belt drive. Stock Taper-Lock Sheaves prescribed for each job. Tri-Matic Overload Release and Backstop are available if desired.

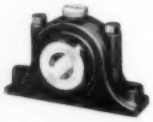
Torque-Arm Speed Reducers are sold from Distributor's stocks—in single reduction and double reduction series—with capacities from 1 to 43 hp and output speeds from 12 to 330 rpm. Standardize on this modern idea in speed reduction—it saves you money.

DODGE MANUFACTURING CORPORATION, 1200 Union St., Mishawaka, Ind.

DODGE
of Mishawaka, Ind.


TAPER-LOCK SPROCKETS AND DODGE ROLLER CHAIN

TAPER-LOCK SHEAVES


DODGE-TIMKEN PILLOW BLOCKS

Call the Transmissioneer, your local Dodge Distributor. Factory trained by Dodge, he can give you valuable assistance on new, cost-saving methods. Look for his name under "Power Transmission Machinery" in your classified telephone directory, or write us.

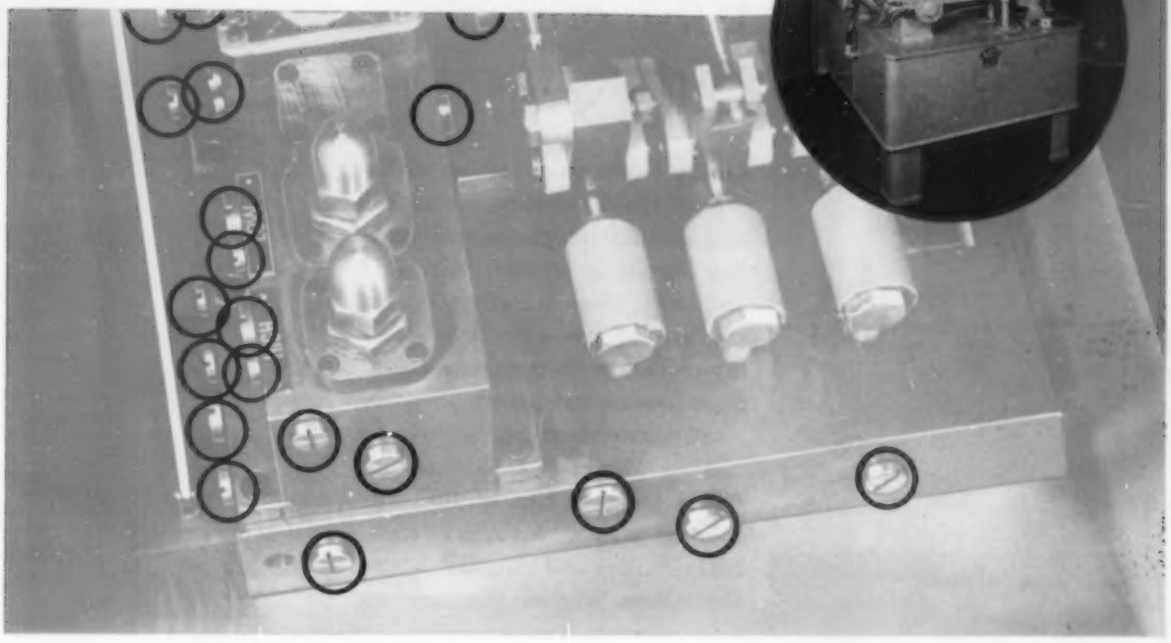
Precision Dyna-seals solve plug sealing problems on NATCO HOLEPAK

old plug design—

used an "O" Ring in a groove. Plugs were expensive, required close tolerances, permitted leakage.

improved plug design—

uses Precision Dyna-seals. Plugs are inexpensive, tolerances not critical. Assembly is much simpler, leakage eliminated.



National Automatic Tool Company, Inc. found *Precision Dyna-seals* the perfect answer to plug-leakage problems on their "Holepak" Hydraulic Control Units. There are now more than 30 *Dyna-seals* on units like the one shown here!

NATCO's improved design employing *Dyna-seals* has lowered the cost of the plugs—reduced installation and maintenance time—and completely eliminated leakage.

Why don't you let *Precision* Engineers help you put *Dyna-seals* in your designs? They assure long life and trouble-free sealing—and that means *savings!*

FREE—Write for your personal copy of our Dyna-seal Engineering Data booklet.

Precision Rubber Products CORPORATION

"O" Ring and Dyna-seal Specialists

Dept. 3 Oakridge Drive, Dayton 7, Ohio Canadian Plant at: Ste. Therese de Blainville, Quebec

Basic Materials

FOR A MILLION PRODUCTS

Alloy Wire, Rod and Strip . . .

Design Engineers are taking advantage of the outstanding mechanical and electrical properties and excellent formability of Alloy Wire, Rod and Strip. Results: Better products, smaller and lighter products, products that are more corrosion-resistant, more heat-resistant, more attractive —and more economical.

Alloy Metal Wire Division can supply you with high quality wire, rod and strip in Stainless Steels, Nickel Alloys and Electrical Resistance Alloys. Why not put these versatile materials to work for you?

SEND FOR FREE HANDBOOKS TODAY

FOR A BETTER DESIGN... *Use Wire, Rod, & Strip*

FOR BETTER PRODUCT PERFORMANCE... *Use Alloys*

Among the alloys we fabricate, you will surely find one with just the right combination of properties for your specific application. And you can profit from the fabrication advantages and material cost and weight savings of wire, rod and strip parts and assemblies. Select the alloy you need from these three functional groups:

STAINLESS STEELS—

Alloy Metal Wire Division can provide you with more than 20 different grades of stainless steels. These include the chromium-nickel Austenitic grades with their outstanding corrosion resistance and good mechanical properties; the high chromium Ferritic grades with their high heat resistance, corrosion resistance, and outstanding cold working properties; and the lower chromium Martensitic grades which can be heat treated to obtain exceptionally high strength and hardness in addition to good resistance to corrosion and high temperatures. Stainless steel Wire, Rod and Strip are used extensively for high strength and corrosion-resistant fasteners, springs and mechanical parts and for welding wire, woven and knitted wire parts, and many other applications.

NICKEL ALLOYS—

A wide variety of Nickel alloys are also available for hundreds of electrical and mechanical applications. The excellent electrical characteristics of nickel are especially advantageous for electronic tube parts, such as grids, cathodes, support rods and pins. Monel, because of its excellent corrosion resistance and good mechanical properties, is also used for many mechanical parts, fasteners and springs.

Inconel provides the valuable combination of outstanding heat resistance, corrosion resistance and high strength required in many applications.

RESISTANCE ALLOYS—

Five grades of electrical resistance alloys are now in production in wire, rod and strip form. These are: Alray A—20 Cr, 80Ni; Alray C—15 Cr, 62Ni, bal Fe; Alray D—18 Cr, 35Ni, bal Fe; Excelsior—45 Ni, 55 Cu; and Ni—Fe alloys.

These high quality alloys find extensive applications in the electrical and electronic fields.

SPECIAL WIRE SHAPES—

You can cut costs and improve product performance with Alloy Metal's Special Shaped Wire. Almost any cross-sectional shape can be made on our wire drawing equipment. These shapes can save you tons of metal and many hours of machining time. Shaped wire can be held to close tolerances and has a smooth, tough, flaw-free surface.

ALLOY METAL WIRE DIVISION
H. K. PORTER COMPANY, INC.
of Pittsburgh
PROSPECT PARK, PENNSYLVANIA

2

Make A Clean Sweep of your Small Gear Problems

G. S. Gears can *clean up* troublesome Gearing problems. Here's why: each unit, however simple or intricate, in runs of hundreds or thousands, measures up to the *most extreme standards of accuracy!* It's this *uniform* excellence that counts . . a precise quality developed and perfected here through 38 years of specializing in making better Small Gears exclusively. This vast experience has brought peace of mind and speedier, less costly assembly operations to a host of critical manufacturers from coast-to-coast. Join this growing group of well pleased G. S. customers next time you need Small Gears. Tell us about your needs. Our capable engineers will be quick to lend you every possible aid.

GET OUR *Free* 6-PAGE FOLDER

See where and how we mass-manufacture Small Gearing to uniformly fine tolerances. This attractively printed 8½ x 11" 6-page folder is punched for ring-binder use. You'll want to keep it handy for frequent reference. It contains 23 pictures of Small Gears, plant views, as well as Diametral and Circular Pitch Tables. Ask for your copy on company stationery, please!

FRACTIONAL HORSEPOWER

GS

GEAR

Specialties, Inc.

2635 WEST MEDILL AVENUE
CHICAGO 47, ILLINOIS

SPURS • SPIRALS • HELICALS • BEVELS • INTERNALS
WORM GEARING • RACKS • THREAD GRINDING

WORLD'S LARGEST EXCLUSIVE MANUFACTURERS OF FRACTIONAL HORSEPOWER GEARING

IF YOU ARE PAYING FOR FRILLS INSTEAD OF FILTRATION

Specify **Bendix-Skinner** RIBBON FILTER ELEMENTS . . .

- LOWER ORIGINAL COST
- SIMPLE, INEXPENSIVE TO INSTALL
- NO EXPENSIVE BACK UP SUPPORT REQUIRED
- PERMANENT TYPE
- HIGH FLOW RATE (EITHER DIRECTION)
- EASILY CLEANED

It seems hard to believe, but you can actually have more efficient filtration at considerably lower cost if you simply use Bendix-Skinner ribbon elements instead of expensive and less adaptable metal edge or metal screen types.

Here's how it works— Bendix-Skinner ribbon elements are inexpensive to begin with and can be installed at far less cost than metallic elements that require special back-up supports. In fact, in practically every instance present metallic-type elements can be changed over to ribbon-type with substantial savings.

Ribbon units are available in diameters from ½" to 6" in any required length with filtration rated at 40 microns (.0016").

Our engineering department will be glad to advise on new installations or to furnish replacement units in a variety of sizes. Write us for details.

Bendix-Skinner

ORIGINATOR OF **MICRONIC** FILTRATION

BENDIX-SKINNER DIVISION OF Bendix

P.O. BOX 135, ROYAL OAK, MICHIGAN

Export Sales: Bendix International Division, 205 East 42nd Street, New York 17, N. Y.

For stress, wear or vibration a

GRIPCO LOCK NUT

will hold tighter, wear longer, cost less!

The Gripco Lock Nut, with its simple, one-piece design, has given industry a tighter, more positive holding action for quicker fastener application at less initial cost. It provides frictional resistance to vibration and loosening torque—is faster to use—permits repeated removal and reapplication—simplifies production—lowers manufacturing and maintenance costs—has improved the durability of hundreds of products—and has insured greater customer satisfaction. If stress, wear or vibration is your problem, specify Gripco Lock Nuts for greater holding power. Impervious to oil or water. Write for samples and full details.

GRIPCO PRODUCTS INCLUDE: Gripco Lock Nuts, New Gripco "Clinch" Nuts, Gripco Hi-Nuts, Gripco Pilot-Projection and Countersunk Weld Nuts with or without Gripco locking feature.

104

GRIP NUT COMPANY

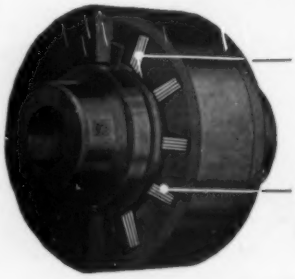
"after 50 years still holding strong"

308-J S. MICHIGAN AVE., CHICAGO 4, ILL.

HERE'S WHY

KUSHION-TORQ

LENGTHENS EQUIPMENT LIFE



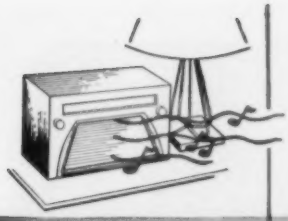
Laminated Kantilever Steel Springs transmit driving action.

Tapered slots move point of driving contact inward as loads increase to automatically stiffen kantilevers.

These Brown Coupling features mean equipment is shock and load protected - - - coupling failure is reduced - - - misalignment is corrected - - - radial and torsional vibration are dampened - - - both drive and driven units last longer.

For complete information shown in Bulletin 28P, write Brown Engineering Co., 108 N. 3rd St., Reading, Pa.

BROWN KUSHION-TORQ COUPLINGS



They needed a plastic to make strong, heat resistant radio parts

KOPPERS POLYSTYRENES

Type 3	General Purpose Polystyrene
Type 7	Improved Heat Distortion Temperature
Type 8	Highest Heat Distortion Temperature
MC-185	"High Impact," Lowest Water Absorption Rate
MC-305	"High Impact," Easy Flow
MC-309	"High Impact," Highest Heat Distortion Temperature
MC-405	"Medium Impact," Easy Flow
MC-409	"Medium Impact," Highest Heat Distortion Temperature

• Most people treat radios with care, but accidents do happen. Take small radios, the kind you use in the breakfast nook or at the bedside. They're often jarred or bumped, so they have to take shock and impact.

Heat is another problem with small radios. They're often carried outside in the hot sun, or they sit near a window where the sun pours in. Both this external, and the internal heat generated by the radio, tend to make some plastic radio cabinets warp out of shape. That's why leading radio manufacturers have been looking for plastic parts that can take both bumps and heat. They found what they wanted in Koppers Heat Resistant—High Impact Polystyrenes. These plastics contain *rubber*, which makes the polystyrene strong and durable.

New radio cabinets, dials and knobs made with these plastics come in bright colors. They are light weight and have smooth, easy-to-clean surfaces.

Koppers Heat Resistant — Heat Impact Polystyrenes have production advantages, too. They are dimensionally stable and flow easily in the mold.

If you would like to get sound engineering advice about the use of Koppers Polystyrenes in your product, write or call your nearest Koppers Office.

Koppers Plastics Make Many Products Better and Many Better Products Possible.

KOPPERS

Koppers Plastics

Guaranteed by Good Housekeeping

KOPPERS COMPANY, INC., Chemical Division, Dept. PE-94, Pittsburgh 19, Pennsylvania

SALES OFFICES: NEW YORK • BOSTON • PHILADELPHIA • ATLANTA • CHICAGO • DETROIT • LOS ANGELES

THE *New* HILLIARD

TWIFLEX

AUTOMATIC CENTRIFUGAL CLUTCH COUPLING *with* *Flexible* ACTION . . .

11 NEW IMPORTANT FEATURES . . .

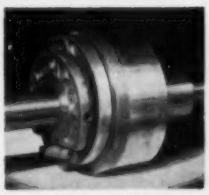
1. Flexible in all directions.
2. Absorbs shock.
3. Limits torsional vibration.
4. Has adjustable idle speed.
5. Can be furnished in automatic free-wheeling type.
6. Smooth starting.
7. No slip under normal load at full speed.
8. Protects driver and driven mechanisms against overload shock.
9. Can be furnished in automatic back-stop type.
10. Prevents torsional resonance.
11. Easily assembled even in blind installations.

If you have problems of misalignment — smooth starting — vibration — overload — or assembly in the manufacture or operation of:

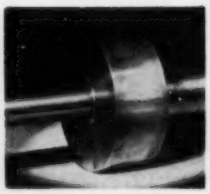
- COMPRESSORS
- BLOWERS
- DIESEL ENGINES
- EXCAVATORS
- REFRIGERATION EQUIPMENT
- TEXTILE MACHINERY
- WIRE DRAWING MACHINES
- FANS
- GASOLINE ENGINES
- BACK STOP BRAKES
- CONVEYORS
- BALL MILLS
- ELECTRIC MOTORS
- GENERATORS
- HIGH SPEED PULVERIZERS
- LARGE OVERHEAD CRANES
- HAMMER MILLS
- MIXERS
- TUBE MILLS
- PUMPS

• LET OUR ENGINEERS CONSIDER YOUR PROBLEMS. TWIFLEX MAY BE THE ANSWER.

THE HILLIARD LINE OF CLUTCHES



Single Revolution Clutch
Write for Bul. 239



Over-Running Clutch
Write for Bul. 231

Slip Clutch
Write for Bul. 300

• WRITE TODAY!
for details of TWIFLEX Coupling in Catalog CE-3

THE HILLIARD *Corporation* 101 W. FOURTH ST., ELMIRA, N. Y.

• MANUFACTURING CLUTCHES FOR OVER 45 YEARS •

Let's Get Together

FOR FAST AND ACCURATE CONVERSION OF YOUR IDEAS...

Into

- Rubber and Fiberglas moldings
- Plastic and rubber extrusions
- Metal stampings
- Vibration and shock mounts

General's design and development engineers translate your problems into finished products in modern, completely equipped plants... the whole job—from the drawing board to the final shipment—is handled as a package assignment. This service includes tool and die-making facilities, self-designed molding and extruding machinery, and a full-scale quality control safeguard at every phase of manufacture.

Why not look into our successful record on motion control products, extrusions, moldings, stampings and special units? For further information fill out the coupon below.

"From Plans to Products in Plastics and Rubber"

THE GENERAL TIRE

Industrial Products Division

WABASH INDIANA

The General Tire & Rubber Company
Industrial Products Division
Wabash, Indiana

☐ Complete products and services (Form 4252)
☐ Vibration products (4240) ☐ Moldings and Extrusions
☐ Have your representative contact us

Name_____ Company_____

Street_____ City_____ State_____

PE-9-54

GREATER ARC RESISTANCE

A New Polyester Glass Fibre Insulating Sheet – INSUROK® XT-200

• If you are looking for an insulating laminate that combines excellent electrical properties with good structural strength, consider this new Richardson laminate. INSUROK XT-200 is an excellent material for pole insulators, cable holders and switches, where arc resistance is important, as well as for motor-generators, transformers, switchgear, electroplating equipment, and various kinds of electrical and electronic heating devices. Moreover, INSUROK XT-200 has very satisfactory fabricating qualities. It is available in sheets 34″ x 34″, in thicknesses of 1/16″, 1/8″, and 1/4″. The Richardson Company will be glad to supply further information and samples.

Send for Data Sheet XT-200

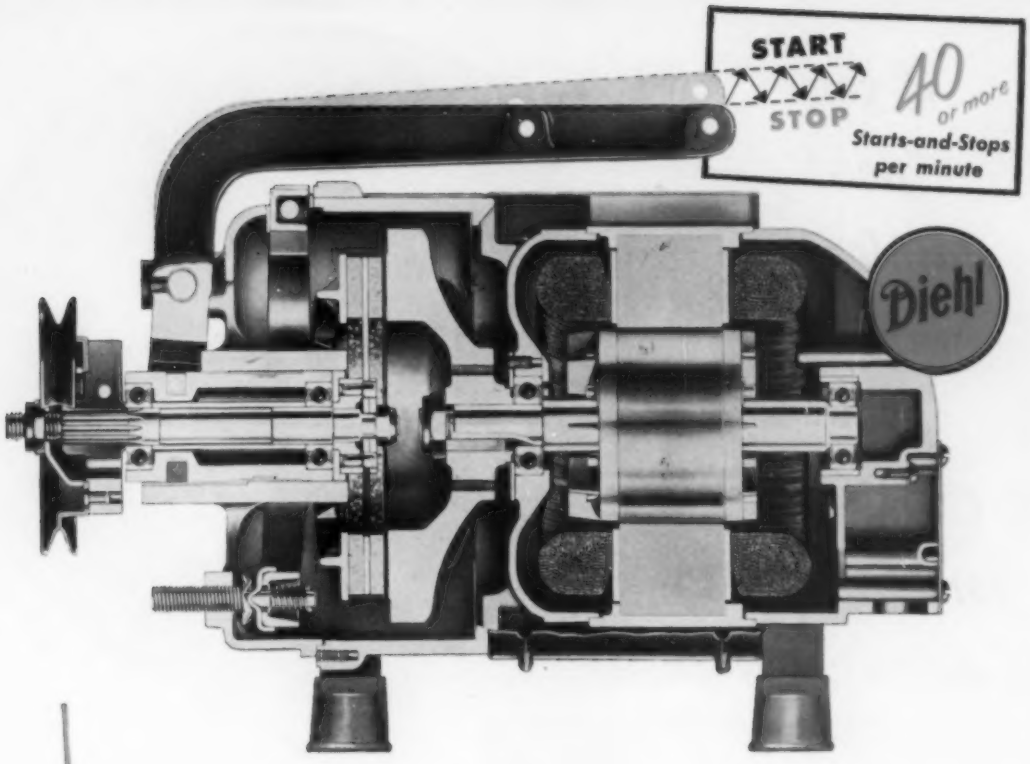
- **GOOD ELECTRICAL PROPERTIES**
- **EXCELLENT STRUCTURAL STRENGTH**
- **HIGH HEAT RESISTANCE**
- **LOW MOISTURE ABSORPTION**
- **PUNCHES COLD TO INTRICATE SHAPES**

The RICHARDSON COMPANY

FOUNDED 1858

2793-P Lake Street, Melrose Park, Illinois (Chicago District)

MELROSE PARK, ILL. | INDIANAPOLIS, IND. | NEW BRUNSWICK, N. J. | NEWNAN, GA. | OGDEN, UTAH | TYLER, TEXAS



New

DIEHL Type "J" Power Transmitters

Unequalled for Repeated Start-Stop Machine Operation

V-BELT DRIVE PULLEY • HEAVY DUTY CLUTCH • POWERFUL BRAKE
HIGH INERTIA FLYWHEEL • TOTALLY ENCLOSED MOTOR

Repeated, rapid start-stop machine operation, impractical with conventional motor drives, is now obtainable with Diehl Power Transmitters. Forty or more starts and stops per minute, hour after hour, are commonplace with these drives. Many manufacturers have made substantial increases in machine output by the shortening of acceleration and deceleration waiting periods.

In one compact unit, the Diehl Power Transmitter incorporates a totally-enclosed fan-cooled ball bearing motor; a high inertia, dynamically balanced flywheel; a positive short-throw, lever-actuated clutch brake assembly. The actuation may be controlled mechanically or electrically.

These Power Transmitters are now used extensively on machine tools, textile machinery, winding and spooling equipment, conveyors and many other types of machinery where repeated starting and stopping is required. In countless instances, the use of Diehl Power Transmitters has made it possible to simplify machines, reduce costs, improve operation, save space and eliminate over-motoring solely for acceleration. Many of *your* troublesome machine drive problems may be solved with Diehl Power Transmitters.

Available in sizes from ¼ H. P. to 5 H. P.
900, 1200, 1800 and 3600 R. P. M.

DIEHL MANUFACTURING COMPANY
Electrical Division of THE SINGER MANUFACTURING COMPANY
Finderne Plant, SOMERVILLE, N. J.

Please send me the following bulletins
☐ Type "J" Power Transmitter Bulletin No. PE-3303.
☐ Consolidated Motor Catalog and Price List No. PE-3310

Name_____
Company_____
Street_____
City_____ State_____

OTHER INTEGRAL AND FRACTIONAL HORSEPOWER MOTORS ARE AVAILABLE IN A WIDE RANGE OF TYPES AND SIZES

if you need stainless wire — call CRUCIBLE for quick delivery

For any diameter from the smallest to half an inch or more . . . in any temper from dead soft to full hard . . . with a bright surface, or with one of many metallic or nonmetallic finishes — yes, for *any* stainless steel wire, call Crucible.

Crucible's modern stainless steel wire mill is the last word in up-to-date production facilities. What's more, this is combined with the very finest metallurgical and quality control setup you can find anywhere. It means, for you, that every coil . . . every length . . . *every inch* of Crucible stainless steel wire can be produced to the most rigid standards of quality — that Crucible stainless wire conforms to precise standards of uniformity that are unsurpassed in the industry.

So, whatever your requirements for stainless wire — cold heading . . . free machining . . . spring . . . rope . . . weaving . . . armature binding . . . slide forming — Crucible's fine new mill is ready to serve you promptly with wire products of the very highest quality. Call your nearest Crucible warehouse for prompt delivery.

CRUCIBLE first name in special purpose steels

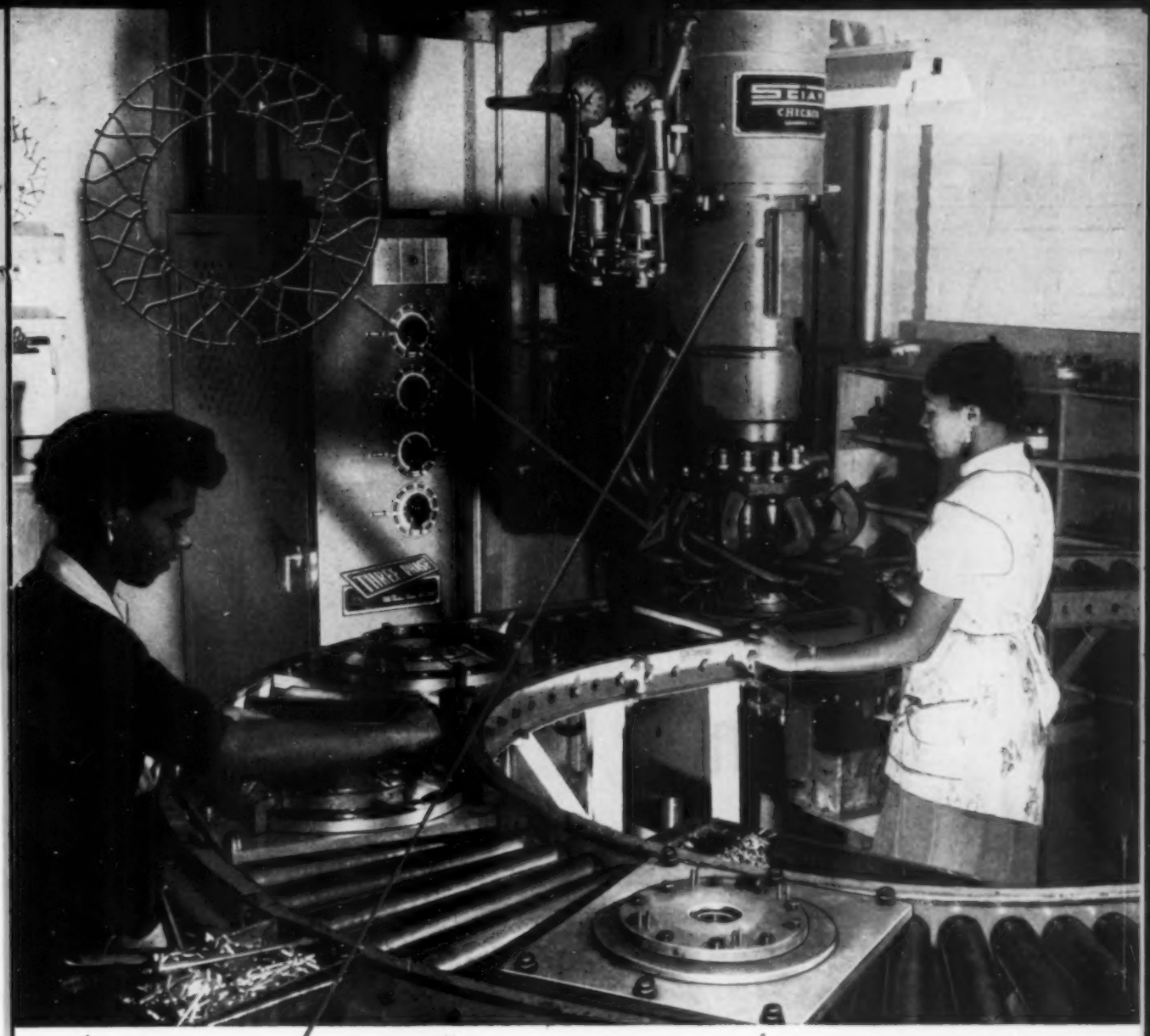
54 years of Fine steelmaking

STAINLESS STEEL WIRE

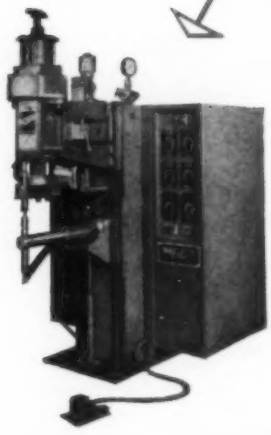
CRUCIBLE STEEL COMPANY OF AMERICA, GENERAL SALES OFFICES, OLIVER BUILDING, PITTSBURGH, PA.

REX HIGH SPEED · TOOL · REZISTAL STAINLESS · MAX-EL · ALLOY · SPECIAL PURPOSE STEELS

Canadian Distributor — Railway & Power Engineering Corp., Ltd.



40 Spokes of .430 Stainless Resistance Welded to 2 Rings in Simulated Wire Wheels



CASCO PRODUCT'S (Bridgeport, Conn.) design of their complex, 42 piece wire wheel assembly presented serious problems of high production, allowable tolerances for positive fit, and cost of fabrication. Sciaky patented Three-Phase resistance welding provided most suitable answers to all requirements.

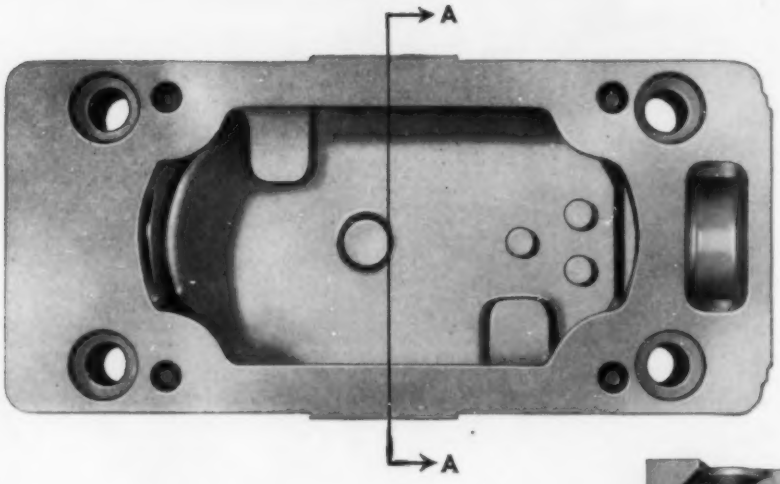
Two standard Sciaky welders complete the entire assembly in only four operations at a production rate of over a thousand per day. No skilled workers are required to produce assemblies that satisfy rigid inspection for alignment and set-down of welds. Sciaky Three-Phase produces smooth fillet welds eliminating special metal finishing. For complete details, write for R.W.A.W., Vol. 3, Number 9.

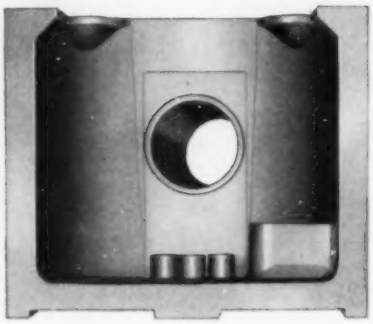
Resistance welding of Casco wire wheels is another fine example of Sciaky's basic thinking—welders designed to do *more useful work* at *lowest operating cost* with *maximum reliability*.

Largest Manufacturers of Electric Resistance Welding Machines in the World

SCIAKY

4913 West 67th Street, Chicago 38, Illinois





Cross Section AA

Alert Designing

with MADISON-KIPP

Zinc and Aluminum Die Castings

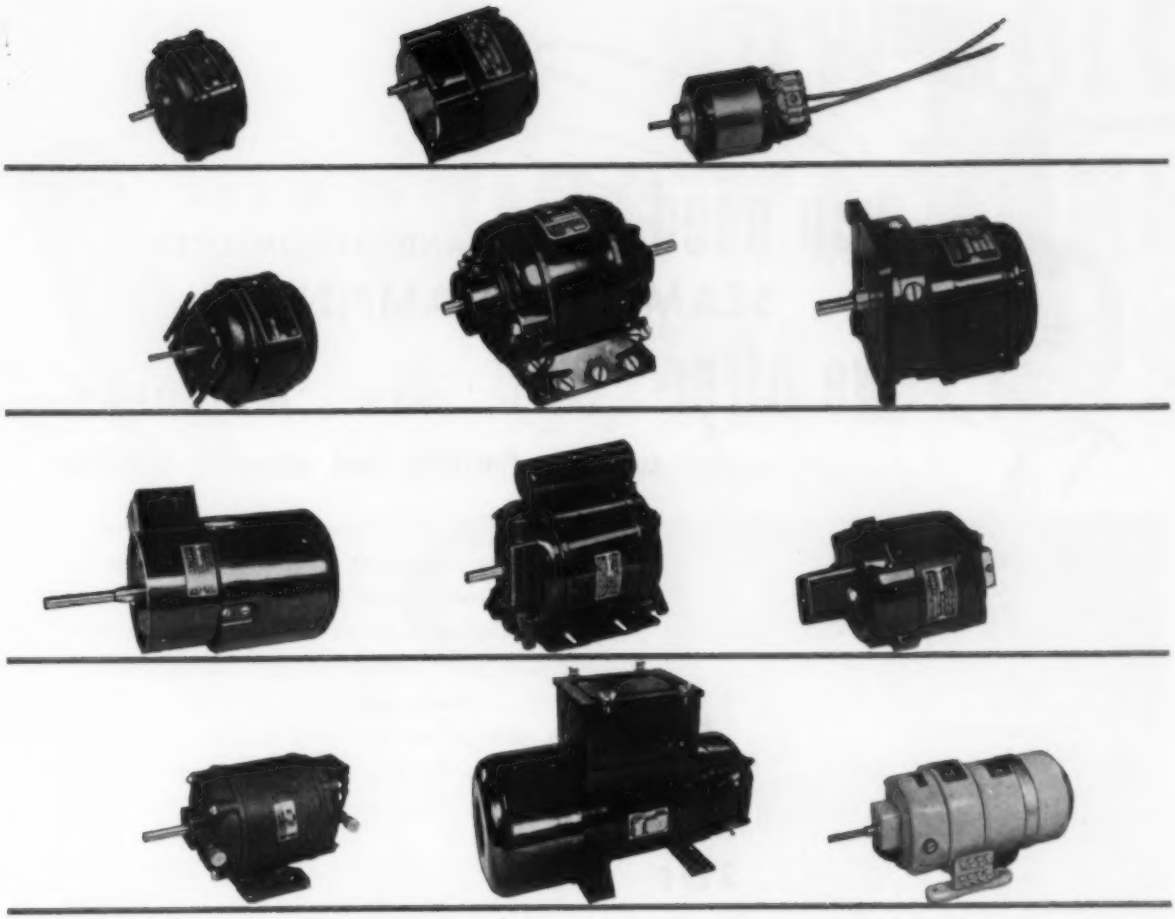
The alert Micro Switch designer profitably defied tradition in the casting here illustrated, and developed a die casting with a die castable undercut.

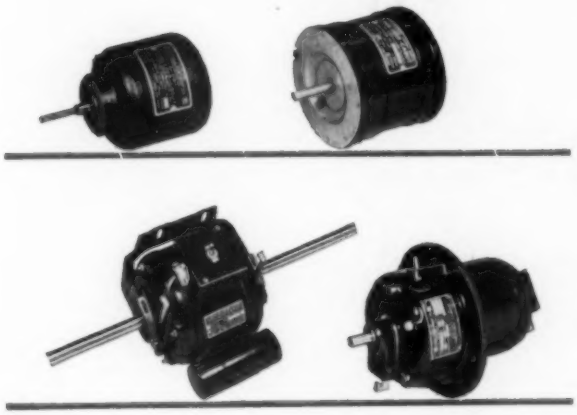
Undercuts should, of course, be avoided whenever possible. When they are essential it is often a good idea to consult with the seasoned Madison-Kipp craftsmen for cooperative effort to help solve the problems involved.

kipp

MADISON-KIPP CORPORATION
206 WAUBESA STREET • MADISON 10, WIS., U. S. A.

• Skilled in Die Casting Mechanics • Experienced in Lubrication Engineering • Originators of Really High Speed Air Tools





each of these HOLTZER-CABOT motors solved a special problem!

Holtzer-Cabot specializes in motor and generator design, and is tooled to produce both AC and DC motors at lowest possible cost, in a wide range of frames, with unlimited varieties of mechanical and electrical features.

Quality motors correctly designed result in lowest ultimate cost.

Bring your small-motor application problem to Holtzer-Cabot. Our experience in developing custom-built motors assures you of a prompt and expert solution.

NATIONAL PNEUMATIC CO., INC. AND **HOLTZER-CABOT** DIVISIONS

125 Amory St., Boston 19, Mass.
Sales Service Representatives in Principal Cities throughout the World

Designers and manufacturers of mechanical, pneumatic, hydraulic, electric and electronic equipment and systems

if you need ... LARGE AND MEDIUM-SIZED SEAMLESS STAMPINGS we offer ... SKILL ... MEN ... MACHINES ...

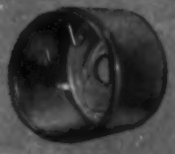
plus complete finishing and assembly facilities

Send for your free copy of our booklet—"Science and Skill in Sheet Metals." It illustrates many jobs produced for G. P. & F. customers . . . and gives interesting information on our abilities and facilities.

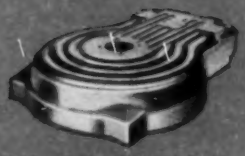
G.P.&F.

Do you have a metal product—or a part of a product—that has to be stamped or drawn? Then it's time to take a good look at what G. P. & F. has to offer. We have the manpower, the machines, the facilities. We can handle your *complete* job from start to finish—relieve you of production details and responsibilities—even package and ship your finished product, if you wish. The booklet shown on the left tells the complete story. Write for it today!

Here are just a few samples of our work...



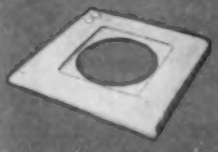
OVERFLOW TUB FOR AUTOMATIC WASHING MACHINE
Welded Construction
Vitreous Enameled
Height, 21"—Diameter, 24"
(Also conventional and spin tubs)



BASE FOR POWER LAWN MOWER
Seamless Drawn Steel
Length, 26"—Width, 19⅛"
Height, 4⅛"

AMMUNITION BOX
(U.S. ORDNANCE)
Carbon Steel—Spray Painted
Length, 10"—Height, 7"
Width, 3⅝"

POWER TOOL SAFETY GUARD
Seamless Drawn
Length of Cover, 29⅜"
Height of Cover, 5⅛"
Width of Cover, 10⅛"



TOP FOR AUTOMATIC WASHING MACHINE
Stainless Steel and Vitreous Enameled
Length, 26"—Width, 25"
Height, 2½"
(Also dryer tops)

SYRINGE HOLDER
Stainless Steel Box, Cover and Rack
Length, 8¼"
Height and Width, 5"

BASE FOR SWIVEL CHAIR
Seamless Drawn Carbon Steel
Length, 25"—Height, 4"

COMMERCIAL HAND DRYER
Seamless Drawn—Vitreous Enameled
Length, 12"—Width, 10½"
Height, 6⅛"

GEUDER, PAESCHKE & FREY CO., 1505 W. St. Paul Avenue, Milwaukee 1, Wisconsin

LITCHFIELD PRODUCTS COMPANY

NOW ROLL WASHING MACHINE WORM GEARS

STRESSPROOF®
SEVERELY COLD-WORKED, FURNACE-TREATED STEEL BARS

This washing machine worm gear is rolled from STRESSPROOF by LITCHFIELD PRODUCTS CO., Litchfield, Mich.

. . . CUT COSTS 40%

For years, STRESSPROOF has been recognized as an ideal worm gear steel. Several washing machine worm gears have been particularly successful. STRESSPROOF worms *outwear* the washing machine. STRESSPROOF's *ease of machinability* and *elimination of heat treating* keep costs down.

Now, the Litchfield Products Company, Litchfield, Michigan, roll the worm on this part for one of the largest washing machine manufacturers. The savings of 40% on the part cost is evident. Lead and pitch diameter requirements are maintained.

And there is no question as to gear life. STRESSPROOF's rugged wearability takes care of that whether the gear be cut or rolled.

STRESSPROOF makes a better part at lower cost. It's available in cold-drawn or ground and polished finish.

ASK FOR . . . your copy of this bulletin, "New Economies in the Use of Steel Bars."

La Salle **STEEL CO.**

Manufacturers of the Most Complete Line of Cold-Finished Carbon and Alloy Steel Bars in America

La SALLE STEEL COMPANY
1430 150th Street
Hammond, Indiana

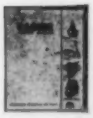
Please send me your new bulletin entitled, "New Economies in the Use of Steel Bars."

Name_____
Title_____
Company_____
Address_____
City_____ Zone___ State_____

RACINE

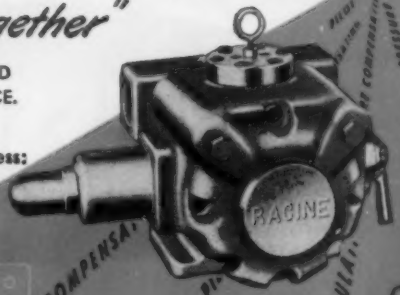
ALL COMPONENTS FOR ANY HYDRAULIC CIRCUIT

"They work better together"



WRITE FOR NEW CATALOG AND NAME OF NEAREST FIELD OFFICE.
Complete Engineering Service Available without charge. Address:

RACINE HYDRAULICS & MACHINERY, INC.
2073 ALBERT ST., RACINE, WISCONSIN, U.S.A.



SEQUENCE • HOLDING • RELIEF • PRESSURE COMPENSA
PRESSURE COMPENSATING
PRESSURE REGULATING • PRESSURE REGULA
FREE FLOW AND RESISTANCE
CHECK • 4-WAY • 2-WAY • FEED • GLOBE

RACINE HYDRAULICS & MACHINERY, INC.
RACINE, WISCONSIN

Mass-Produced at Less Cost...

by HAYNES Investment Casting
Trade-Mark

PRODUCED FOR 74 PER CENT LESS

Originally this turbine wheel was machined from a 20-lb. forging to a final weight of a little over 1 lb. Now the part is produced by investment casting and only 2 oz. of metal is removed. Investment casting has brought about a 74 per cent reduction in production costs by saving strategic metal and machine time.

COST CUT 60 PER CENT

This investment-cast motor mount was made in a high-strength alloy at 60 per cent less than the cost of a forging. The mount bears the entire weight and torque of a 100-lb., 15-horsepower aircraft starter motor. The investment-cast parts require only four simple finishing operations.

ASSEMBLY COSTS REDUCED

Investment casting made it possible to produce this cylinder head in one piece, eliminating extra assembly costs. Machining was reduced to a minimum. The design of the part is special to investment casting. The castings weigh about 25 lb. and are 7 in. in diameter.

HAYNES *investment castings can solve some of your own production problems. For more information, contact the nearest Haynes Stellite Company office listed below.*

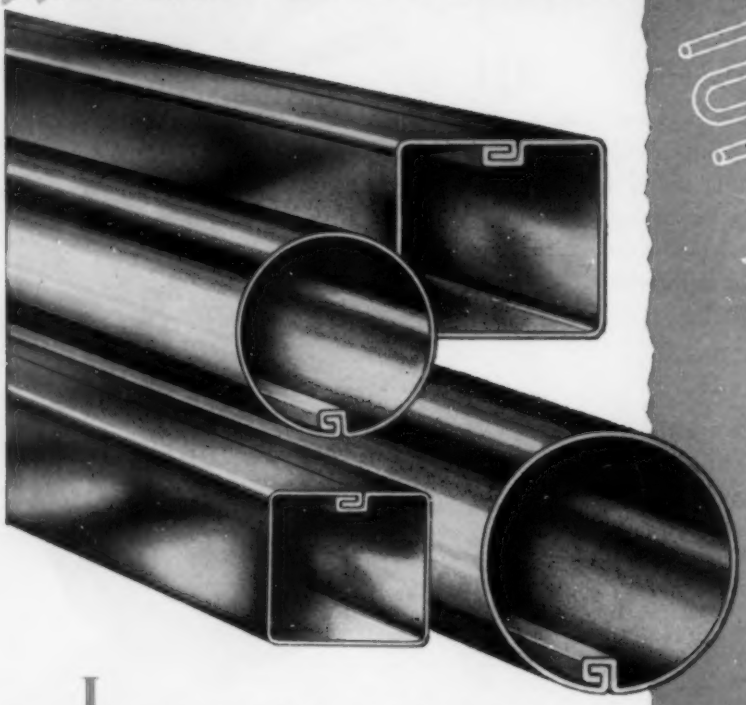
"Haynes" is a registered trade-mark of Union Carbide and Carbon Corporation.

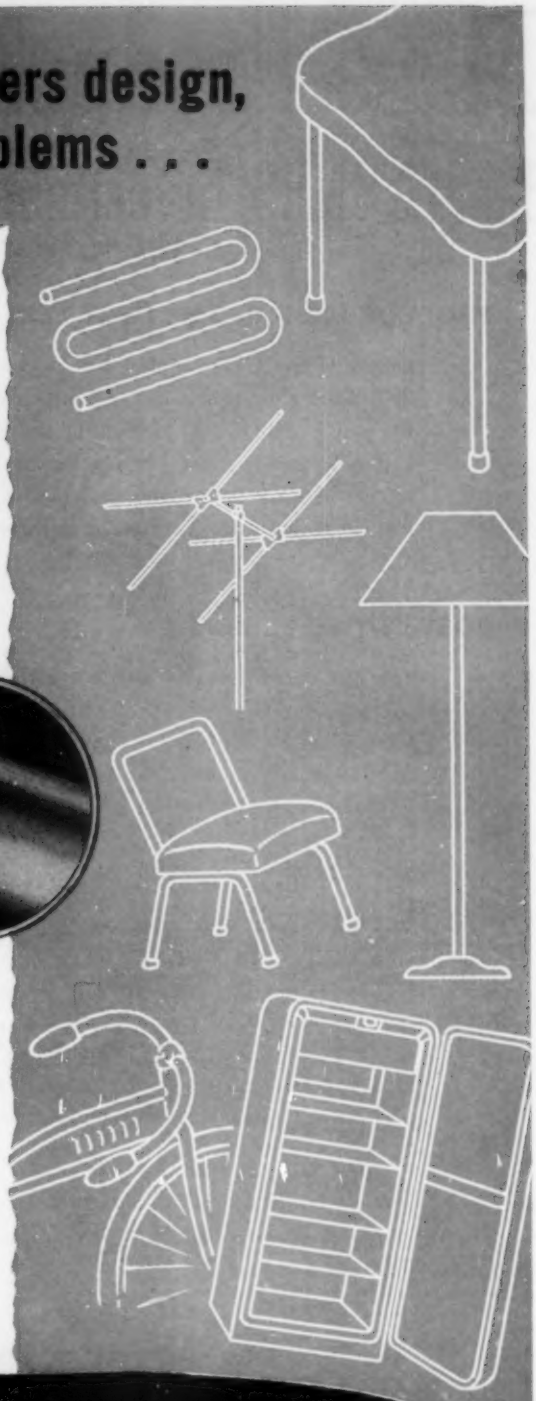
HAYNES INVESTMENT CASTINGS
TRADE-MARK

Sound, dense, high-strength parts available in cobalt-base alloys, nickel-base alloys, iron-base alloys, stainless steels, and alloy and carbon steel.

Haynes Stellite Company
A Division of
Union Carbide and Carbon Corporation
UCC
General Offices and Works, Kokomo, Indiana
Sales Offices
Chicago — Cleveland — Detroit — Houston
Los Angeles — New York — San Francisco — Tulsa

Roll Formed Tubing answers design, production and cost problems . . .





Less expensive Roll Formed Lockseam Tubing cuts costs on all tubing jobs. In many cases it does a better job than more expensive tubing. Lockseam Tubing can be bent as easily as other types. Your tubing is delivered ready for use. Send us your blueprints for steel or aluminum Lockseam Tubing. Let us prove that Roll Formed can help you produce a better product at less cost. For complete details on Roll Formed tubing and special shapes write for Catalog 1053. It tells the complete Roll Formed story.

ROUND SIZES — LOCKSEAM TUBING

Section No.	Wall Thickness	O.D.	Section No.	Wall Thickness	O.D.
2172	.018	½"	2096	.025—.030—.035	1"
2173	.018	⅝"	2020	.025	1⅛"
2103	.025—.030	¾"	2030	.030—.035—.040	1¼"
2174	.025—.028—.032	⅞"	2176	.030	1½"

ROLL FORMED PRODUCTS COMPANY

MAIN OFFICE AND PLANT
3750 OAKWOOD AVENUE • YOUNGSTOWN, OHIO

New Cutler-Hammer 9101 Switch joins a distinguished family of Small Motor Control Champions

ELECTRICAL INSTALLERS of the many devices for home, store or factory using motors up to 1 HP praise easy wiring of the new Cutler-Hammer 9101.

MACHINERY BUILDERS have been quick to adopt the new Cutler-Hammer 9101 for standard original equipment . . . better protection plus speedier installation.

AUTHORIZED DISTRIBUTORS everywhere proudly feature the new Cutler-Hammer 9101 Motor Switch . . . offer two-pole and single-pole models from stock.

TWO-POLE SWITCH FULLY DISCONNECTS MOTOR AND EQUIPMENT FROM POWER
FAMOUS C-H EUTECTIC OVERLOAD PROTECTION. FLIP TO "OFF" RESETS
SWITCH MECHANISM FITS IN ORDINARY HANDY BOX FOR FLUSH WALL MOUNTING
CUTLER-HAMMER
OFF
CUTLER-HAMMER
MOTOR CONTROL
C-H

CUTLER-HAMMER MOTOR CONTROL

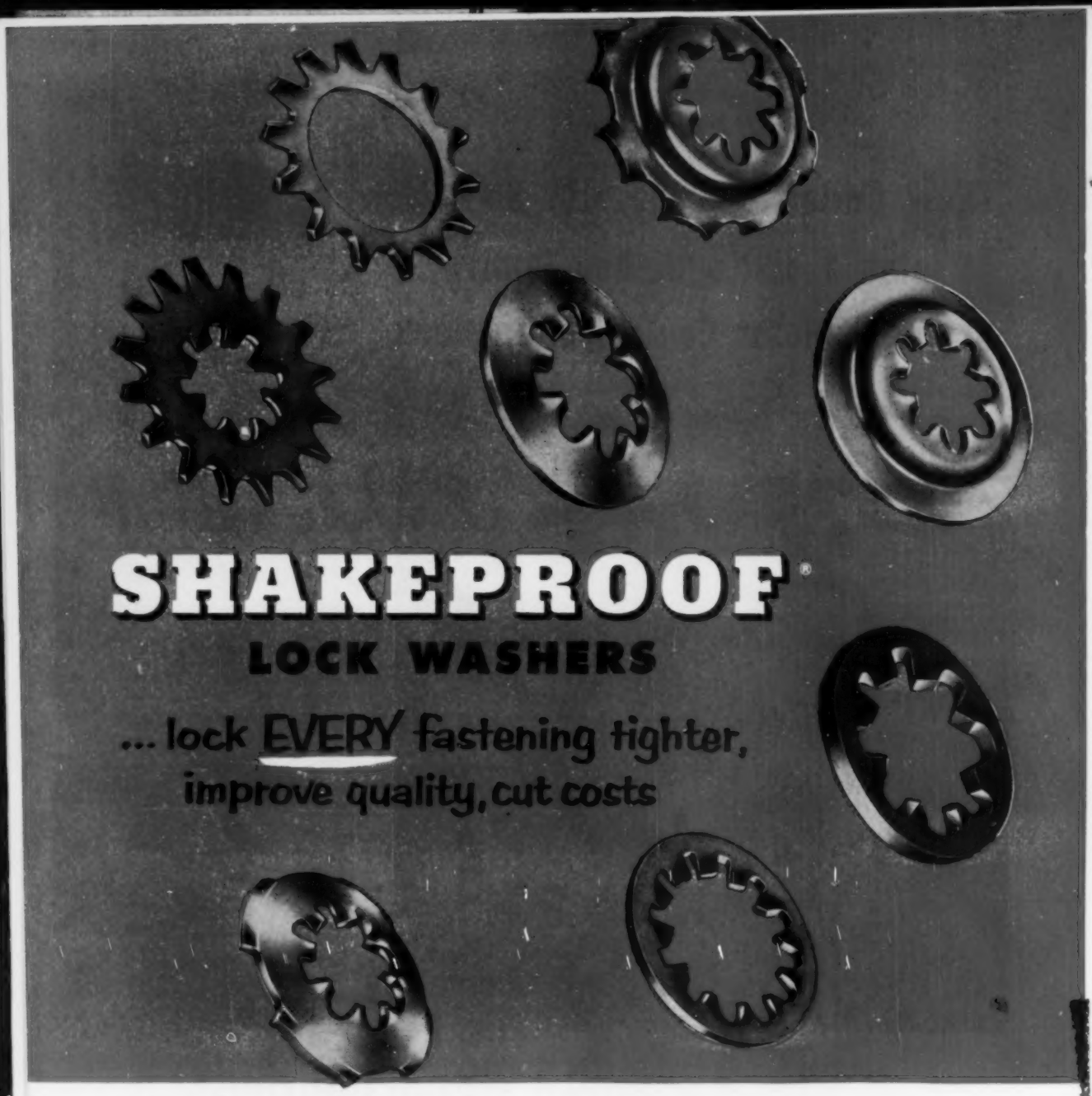
CUTLER-HAMMER 9115 MANUAL STARTER—For dependable across-the-line starting and eutectic overload protection of single phase and polyphase motors up to 2 HP.

CUTLER-HAMMER 9586 AUTOMATIC STARTER—C-H 9586 Size 0 Automatic Starter permits economical and safe remote pushbutton control of motors up to 2 HP.

CUTLER-HAMMER 9441 DRUM SWITCH—Choice of the men who want the best in a switch for reversing or special control of machines in the home workshop.

CUTLER-HAMMER 10017 PRESSURE SWITCH—Both manufacturers and installers of pumps and water supply units say this widely used pressure control switch is the finest.

Copyright 1954, Cutler-Hammer, Inc., Milwaukee 1, Wis



IN STOCK—TYPES AND SIZES TO MEET YOUR SPECIFIC LOCK WASHER NEEDS!

Locking a countersunk screw was a problem until Shakeproof developed Countersunk Type Lock Washers. Tapered twisted locking teeth give positive protection against loosening . . . put a stop to costly rejections and customer complaints due to loose screws. Assembly is faster, too, because screws lock tight at lightest touch . . . you get a perfect fastening every time!

Whatever *your* lock washer needs, there's a Shakeproof Lock Washer specifically designed for the job . . . designed to save costs and time on the assembly line!

SHAKEPROOF®

"Fastening Headquarters"

DIVISION OF ILLINOIS TOOL WORKS

St. Charles Road, Elgin, Illinois • Offices in principal cities
In Canada: Canada Illinois Tools Limited, Toronto, Ontario

for even greater savings, buy them PRE-ASSEMBLED

SEMS-BY-SHAKEPROOF
With Countersunk Lock Washers

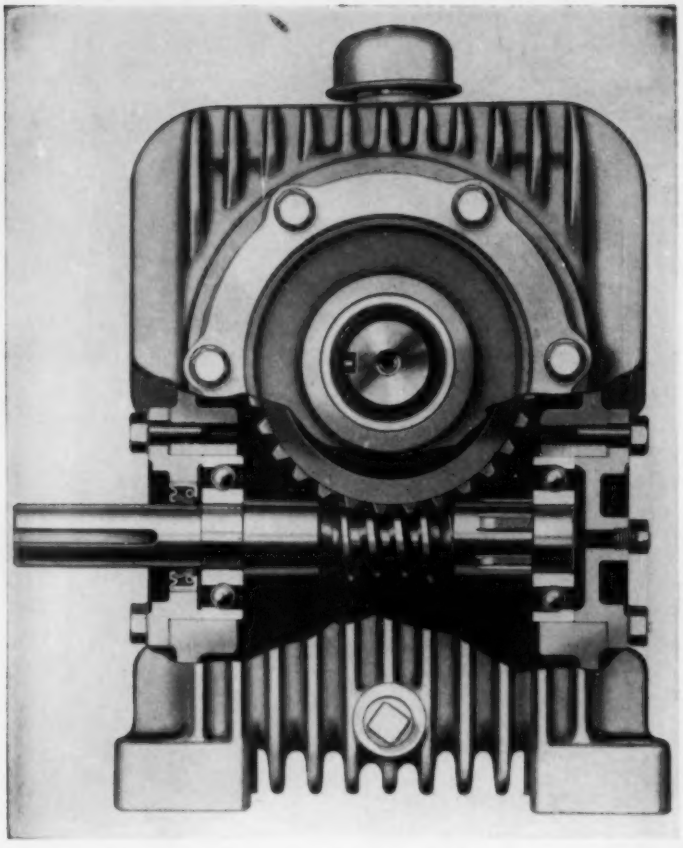
All Shakeproof® Lock Washers can be pre-assembled with screws to eliminate separate washer handling . . . and reduce costs! You're certain to improve quality, too, because the lock washer can't be omitted.

KEPS®

Shakeproof also developed pre-assembled nuts and lock washers. They are fast, easy to use, always lock tight. With KEPS, every fastening is protected against vibration loosening.

FREE testing sample kit

Test Shakeproof Lock Washers on your own products . . . right in your own product laboratories. See how they lock even tighter as vibration increases; improve quality . . . and cut costs in your assembly. Send for your kit now.



MORE HP PER POUND

•

MORE HP PER CUBIC INCH

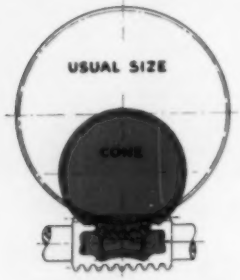
•

MORE HP PER DOLLAR

TAKE A LOOK AT EFFICIENCY

. . . it belongs in every driven product

You're looking at the "innards" of the most efficient worm geared speed reducer available today. It's Cone-Drive Gear's exclusive double-enveloping worm gear design, which means more load-carrying capacity, size for size, than any other type of right-angle speed reducer.



This simple design, with the gear and worm literally "wrapped" around each other, means a space and weight savings that often makes the difference between a compact, efficient product and just another machine.

You can specify (from stock) any one of 190,000 standard models of Cone-Drive gears to handle loads from fractional to 800 hp. You can have ratios from 5:1 to 4900:1. Fan-cooled or water-cooled models available if you should need them.

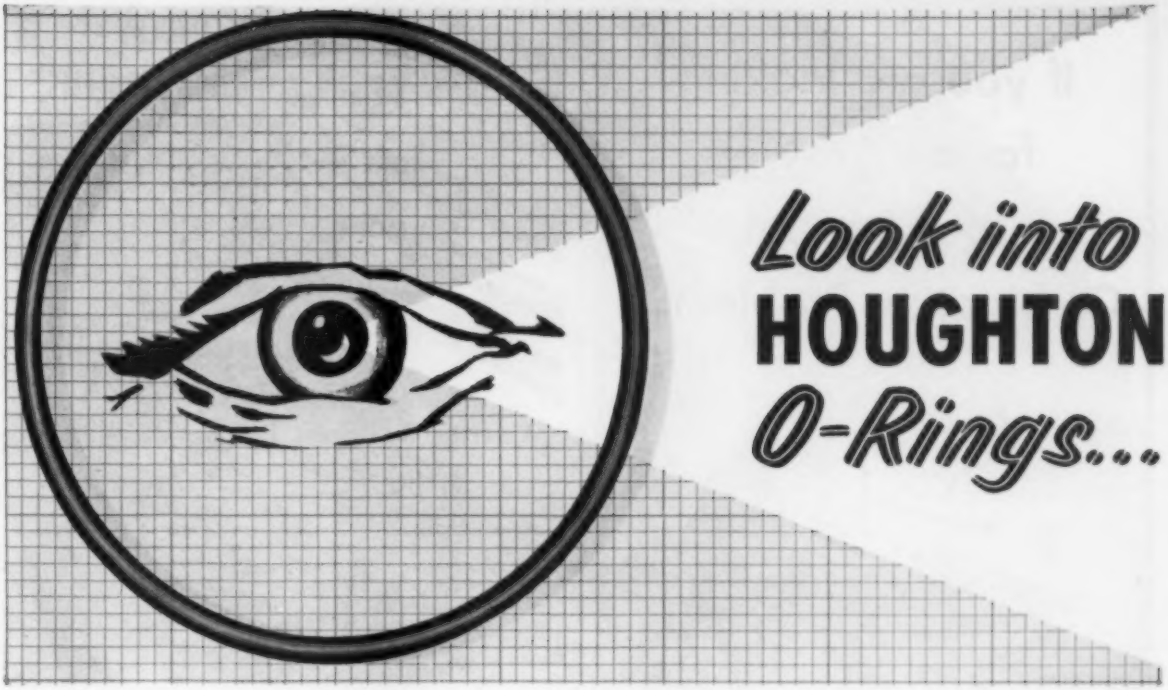
Interested? Get complete details in Bulletin 8901-50.

CONE-DRIVE GEARS

Division, Michigan Tool Company

DOUBLE ENVELOPING GEAR SETS & SPEED REDUCERS

7171 E. McNichols Road • Detroit 12, Michigan



Look into HOUGHTON O-Rings...

...YOU'LL FIND THE SMOOTH SURFACE FINISH

that reduces wear and friction in moving seals, because Vix-Syn synthetic rubber packings are made in highly polished molds;

...YOU'LL SEE EXCEPTIONAL UNIFORMITY

in dimension and density—a close-grained structure developed by Houghton engineering that assures longer service life.

...YOU'LL FIND A WIDE CHOICE OF COMPOUNDS

available to meet many specifications. Large stocks carried on most sizes, for prompt delivery.

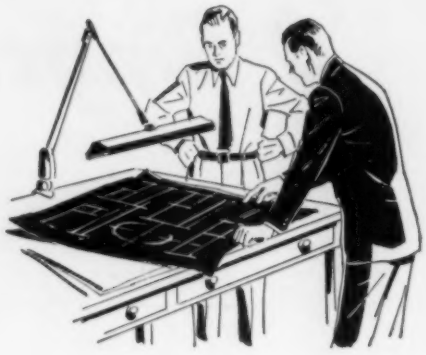
VIM and VIX-SYN PACKINGS

Synthetic Rubber, Leather and Rubber-Impregnated Leather; all types and sizes described in Houghton's "Packing Standards Book" which is accepted as standard by industry. Get your copy—and latest Packings bulletins—from the Houghton Man or E. F. Houghton & Co., 303 W. Lehigh Ave., Philadelphia 33, Pa.

...products of E F HOUGHTON & CO.
PHILADELPHIA · CHICAGO · DETROIT · SAN FRANCISCO

Ready to give you on-the-job service...

If you are looking
for an Answer
to a Special
Carburetion Problem...



You are looking
for

Zenith

Zenith's skill and experience have always been concentrated to one particular end—to provide the finest in specialized carburetion. Through the years Zenith has dealt with every type of engine—ranging from single cylinder lightweights to the most rugged and powerful of gasoline engines—applying 25 years of experience to the mastery of almost every conceivable carburetor problem. In engineering the individual carburetor to the specific requirements of the job, questions of placement, efficiency of performance, and economy of operation are considered from blueprint to production stage. If you are looking for the answer to a particular carburetion problem, you are looking for Zenith. Inquiries will receive prompt attention.

®REG. U.S. PAT. OFF.

ZENITH CARBURETOR Division of **Bendix**
AVIATION CORPORATION
696 Hart Avenue
Detroit 14, Michigan
MANUFACTURERS OF FINE CARBURETORS AND FUEL FILTERS
Export Sales: Bendix International Division, 205 East 42nd St., New York 17, N. Y.

LET *Ametron* RECORDERS
SOLVE **YOUR** COUNTING PROBLEMS

for ANY counting or timing job!

Ametron Recording Counter

Consists of two basic electrical circuits, both normally open. Momentary closure of the counting circuit advances indexing device one step. Momentary closure of print circuit causes unit to print accumulated count. Automatic reset to zero available if desired. A wide variety of timing mechanism available as standard equipment.

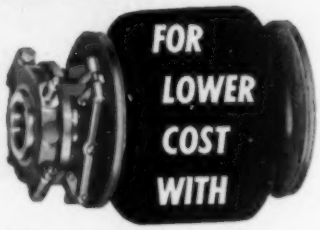
This unit may also be furnished to record elapsed time in these increments: 1/10 minute, 1/100 minute, 1 second and 1/10 second. Counting unit may also be equipped for direct drive from a rotating shaft to count revolutions in units of one tenth.

● THE STANDARD OF ACCURACY SINCE 1888 ●

Write for circular RC 31.

STREETER-AMET COMPANY
4101 RAVENSWOOD AVENUE • CHICAGO 13, ILLINOIS

DESIGN



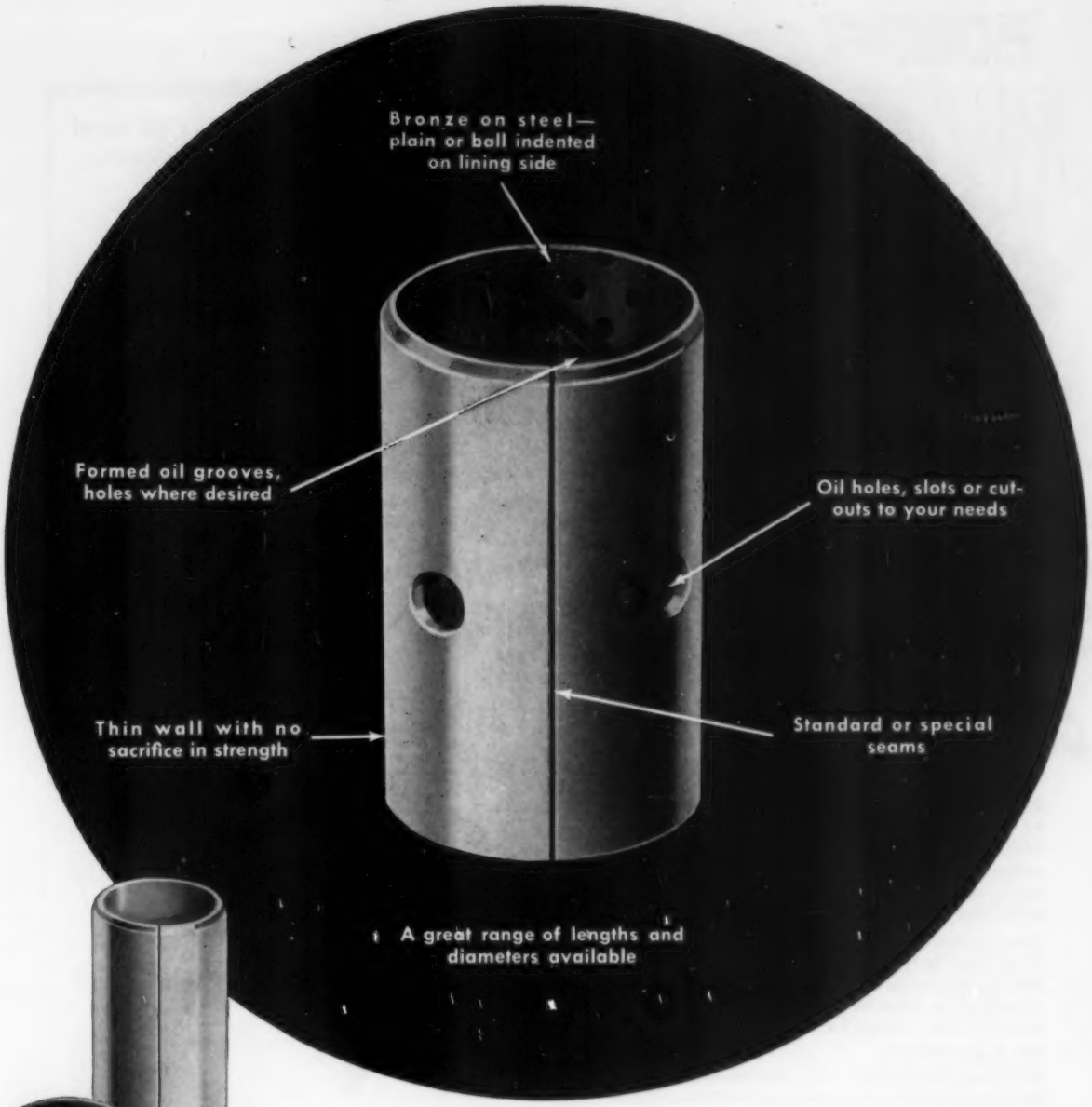
ROCKFORD CLUTCH engineers are helping product designers reduce costs — by making possible *quicker clutch installation, easier clutch adjustments,* and reducing *after-sale service* to a minimum. Because ROCKFORD CLUTCH precision, capacity and stamina are greater than ever, product owners' up-keep costs are lower. Now is the time to have ROCKFORD clutch engineers give *your* product the benefit of lower clutch cost plus competitive operating advantages.

Send for This Handy Bulletin

Shows typical installations of ROCKFORD CLUTCHES and POWER TAKE-OFFS. Contains diagrams of unique applications. Furnishes capacity tables, dimensions and complete specifications.

ROCKFORD CLUTCH DIVISION
BORG-WARNER
209 Catherine Street, Rockford, Illinois

ROCKFORD CLUTCHES



Also available in tin-base or lead-base babbitt on steel.

Get bearing performance at bushing cost. Save material, time and labor with Federal-Mogul bimetal rolled split bushings. Quality production in large volume runs for hundreds of uses can mean savings in *your* application.

FEDERAL-MOGUL CORPORATION, 11043 Shoemaker, DETROIT 13, MICHIGAN

FEDERAL Mogul since 1899

FEDERAL-MOGUL

Sleeve bearings in all designs and sizes; cast bronze bushings; bimetal rolled bushings; rolled split bushings; washers, spacer tubes, precision bronze parts and bronze bars.

YOU MINIMIZE ONE CAUSE OF WASTED MANHOURS WHEN YOU USE

Bond® STOCK GEARS

Even the best gears made must be replaced sooner or later—but there's no need for man and machine to stand idle waiting for replacements to be made to order. When Bond Stock Gears are used on a machine, replacements can quickly be obtained out of stock from the nearest Bond Distributor.

Time is saved in ordering, too, because every Bond Stock Gear is identified by its own individual symbol. There's no need to measure anything—and no chance of an order being misinterpreted. The gear delivered will always be interchangeable with the one to be replaced.

Add these advantages to the machinery you design and/or manufacture by specifying Bond Stock Gears. For information on the complete line, write for Bond Catalog 67.

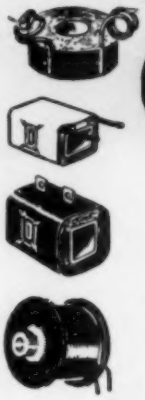
Carried in stock by
DISTRIBUTORS IN PRINCIPAL CITIES
Consult your local Classified Directory or write to

CHARLES BOND COMPANY
617-23 Arch Street, Philadelphia 6, Pa.

Bond®
STOCK GEARS
SPEED REDUCERS

for precision coils to meet exacting industrial needs...
Depend on

DORMEYER



Paper section, from wound and bobbin wound coils for practically every electrical industrial purpose—quantity produced to your exact specifications for top quality at lowest cost. All uses adapted to your extraneous variables. Two large plants for quick delivery of big or small orders. Over 30 years of coil specialization.

Use our cooperative service. Send B/P, sample or data for immediate estimate. No obligation.

DORMEYER INDUSTRIES
FACTORIES IN CHICAGO AND KENTLAND, INDIANA
3414 MILWAUKEE AVE. • CHICAGO 41, ILL.

MAYLINE

4-POST TABLE WITH DRAWERS

Plan Efficiently on *Mayline* Drafting Tables

METAL PLAN FILE

A safe combination — plans made on Mayline Tables, stored in Mayline Plan Files.

Write for catalog 8A and consumer Price List.

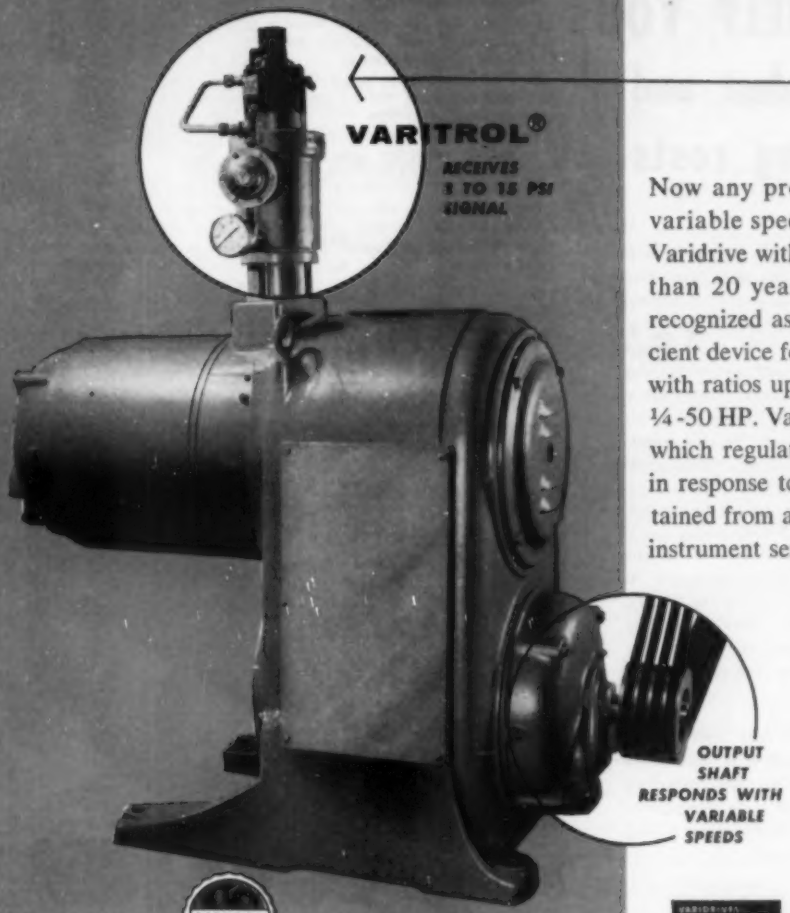
Symbol of MAYLINE *Superiority*

V-MODEL TABLE WITH FOOTREST

MAYLINE CO.
605 No. Commerce St.
Sheboygan, Wis.

MAYLINE
MAYLINE
MAYLINE

AUTOMATIC CONTROL OF VARIABLE SPEEDS



MOTORS

¼ TO 50 HP

U.S. VARIDRIVE

THE MIRACLE MOTOR

WITH

VARITROL®

Now any process requiring automatic variable speeds can be driven by U. S. Varidrive with Varitrol control. For more than 20 years the Varidrive has been recognized as the most compact and efficient device for obtaining variable speeds, with ratios up to 10:1 and capacity from ¼-50 HP. Varitrol is a new control device which regulates the speed of a Varidrive in response to a signal. The signal is obtained from a standard type of pneumatic instrument sensitive to such variables as:

Temperatures	Liquid Level
Humidity	Weight
Pressure	Tension
Speed	Position

Many firms are increasing productivity with Varitrol control. Quality of product is improved, human effort is reduced. Lower costs result in better salability of your products.

U. S. Engineers are experienced in variable speed problems, and can help you apply Varidrives to your process.

Request new Bulletin on Varidrives with Varitrol automatic control. Indicate if you would like additional literature on Varidrives.

REQUEST FOR VARITROL BULLETIN

U. S. ELECTRICAL MOTORS INC. PE-9
Box 2058, Los Angeles 54, Calif. or Milford, Conn.

☐ Send also 16-page 4-color Booklet on Varidrives

NAME_____

COMPANY_____

ADDRESS_____

CITY_____ ZONE___ STATE_____

METAL STAMPINGS

McCauley's 3 Point SERVICE

WILL HELP YOU

improve your product and cut your stamping costs

1 DESIGN DIAGNOSIS

If your product is in the design stage it will pay you to let our engineers analyze the stampings. Through our experience in metal flow we may be able to suggest changes that will lower production costs. We may even see a way to make it lighter without reducing strength — saving material cost. To many customers we have suggested changes that improved the original product. Yes, experienced eyes can spot the pitfalls that spell trouble and expense later on.

2 PRODUCTION EQUIPMENT

McCauley press equipment covers a range from small inclinable and punch presses to large double and single crank presses up to 200 tons capacity. We also have double action presses, etc. We have our own die shop and sheet metal cutting department.

3 FINISHING FACILITIES

Your parts can be finished in our own plant ready for assembly. Our service includes spray painting, parkerizing, galvanizing bath, etc. Completion under one responsibility insures control of production and delivery to you when promised.

FOR 50 YEARS
MAKING BETTER STAMPINGS — BEST!

This is one of our 2 factories.

McCauley METAL PRODUCTS, INC.
BUFFALO, N. Y.
Suppliers of Metal-Fabricated Parts to Principal Manufacturers

---

A PENNY SAVED IS PROFIT EARNED

WITH YOUR

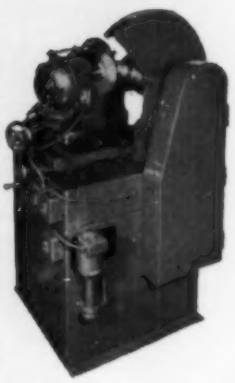
RUTHMAN GUSHER

COOLANT PUMP

Low in initial cost, efficient in operation, you can depend on your Gusher Coolant Pump for *economical* operation.

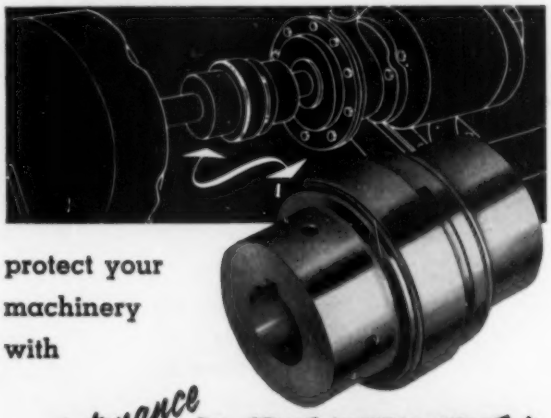
1—They use less power when throttled and require no packing or priming.
2—Pre-lubricated heavy-duty ball-bearings reduce maintenance attention.
3—Electronically balanced rotating assembly cuts wear through vibration to a minimum.

For economical, efficient, long lived Coolant Pumps always specify Ruthman Gusher Coolant Pumps.



Illustrated is a CC-4S Rogers Circular Knife grinder equipped with a Gusher Coolant Pump.

THE RUTHMAN MACHINERY CO.
1818 Reading Road Cincinnati, Ohio



protect your machinery with

maintenance free **LOVEJOY**

FLEXIBLE COUPLING

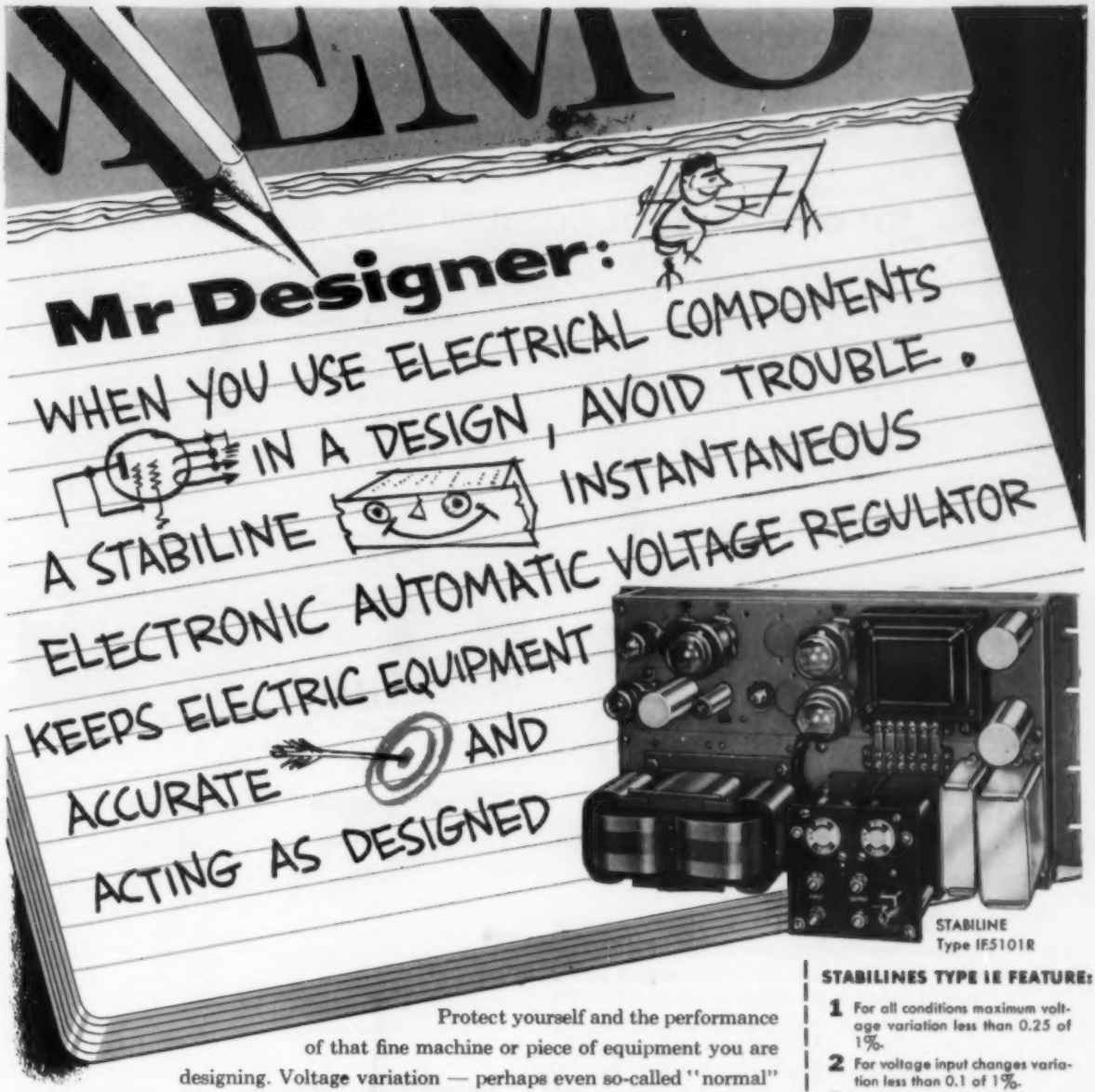
When you install Lovejoy Flexible Couplings you get more than just long-lasting smooth power transmission. You get maximum protection against surge, backlash and starting torque. You get reduced down-time and less maintenance, since cushions can be changed without shutdown and Lovejoy Flexible Couplings never require lubrication.

Accurately machined bodies and jaws and cushioning materials engineered to the load conditions are combined in a compactly designed coupling to keep your machinery running better . . . longer.

Types and sizes for all applications

Send for complete catalog . . . contains full technical data and handy selector charts for your convenience. Yours without obligation.

LOVEJOY FLEXIBLE COUPLING CO.
4873 West Lake St. Chicago 44, Ill.
Also Mfrs. of Universal Joints and Variable Speed Pulleys



STABILINE
Type IE-5101R

Protect yourself and the performance of that fine machine or piece of equipment you are designing. Voltage variation — perhaps even so-called "normal" variation — may throw it out of "kilter". The equipment gets into trouble . . . so does your sales manager . . . so do you. Effective automatic voltage regulation prevents varying voltage trouble. And you'll find the STABILINE Type IE the finest of its kind. Available in ratings from 0.25 to 5.0 KVA. Write for details.

STABILINES TYPE IE FEATURE:

1. For all conditions maximum voltage variation less than 0.25 of 1%.
2. For voltage input changes variation less than 0.1 of 1%.
3. Correction speed — 3 to 10 cycles.
4. Waveform distortion never over 3%. Usually under 2%.
5. Models for 50 and 60 cycle operation in 115 and 230 volt ratings. 0.25 to 5.0 KVA capacity.

Be sure to see the Superior Electric Mobile Display when it is in your area.

THE SUPERIOR ELECTRIC COMPANY

1909 CLARKE AVENUE, BRISTOL, CONN.

Manufacturers of: Powerstat Variable Transformers • Stabiline Automatic Voltage Regulators • Voltbox A-C Power Supplies • Powerstat Light Dimming Equipment • Varicell D-C Power Supplies • Superior 5-Way Binding Posts

THE SUPERIOR ELECTRIC COMPANY
1909 Clarke Avenue, Bristol, Conn.

Please send Bulletin S351 describing STABILINE Automatic Voltage Regulators.

Name.....

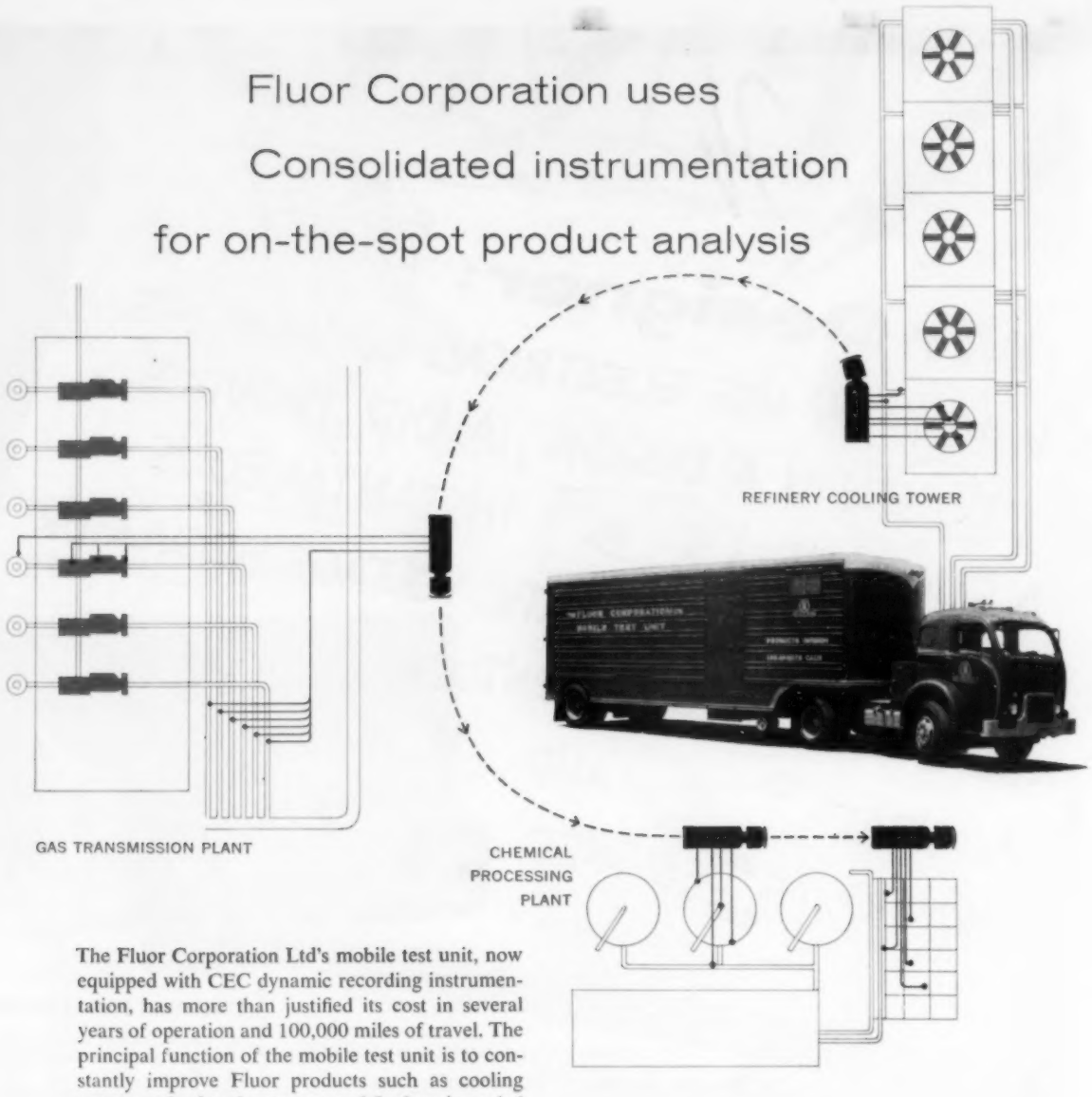
Position.....

Company Name.....

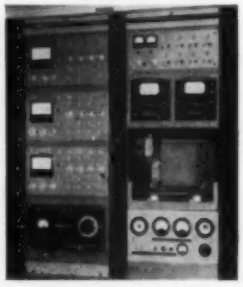
Company Address.....

City.....Zone.....State.....

Fluor Corporation uses Consolidated instrumentation for on-the-spot product analysis



The Fluor Corporation Ltd's mobile test unit, now equipped with CEC dynamic recording instrumentation, has more than justified its cost in several years of operation and 100,000 miles of travel. The principal function of the mobile test unit is to constantly improve Fluor products such as cooling towers, pulsation dampeners and fin fan air-cooled heat exchangers by on-the-spot dynamic testing under actual operating conditions. Using a 14-channel Consolidated Recording Oscillograph, Carrier Amplifiers, Transducers and associated CEC equipment, the mobile unit can measure and permanently record every physical phenomenon encountered in the operation of Fluor's products for the petroleum and petro-chemical industries. The attractive mobile unit in its specially built van trailer serves other purposes aiding the solution of field engineering problems and conducting basic research.



Consolidated dynamic recording equipment: recording oscillograph, vibration meters, bridge balance and carrier amplifiers, are rack-and-panel mounted in Fluor's mobile research laboratory.

Free Catalog. *Write for illustrated brochure "Data Processing Instruments." Ask for Bulletin 1301-X2.*

Consolidated Engineering
CORPORATION
300 North Sierra Madre Villa, Pasadena 15, California

Sales and Service through **CEC INSTRUMENTS, INC.,** *a subsidiary with offices in: Pasadena, Atlanta, Chicago, Dallas, Detroit, New York, Philadelphia, Washington, D. C.*

ANALYTICAL INSTRUMENTS FOR SCIENCE AND INDUSTRY

NOW!

PREMIUM QUALITY "O" RINGS AT MASS PRODUCTION PRICES!

LINEAR ROTO-MOLDED "O" RINGS

The price advantage formerly enjoyed by injection molded "O" Rings no longer exists! LINEAR, with an exclusive, new and revolutionary process, now brings you ROTO-MOLDED "O" Rings—true compression-molded quality, at prices competitive with ordinary rings!

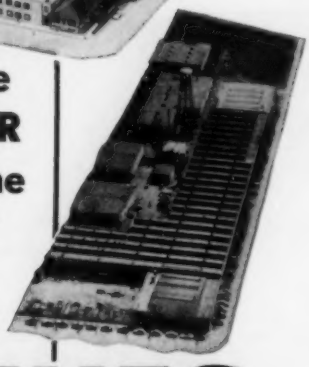
LINEAR'S new ROTO-MOLDING process is an entirely new method of compression molding that eliminates flash . . . produces a tough homogeneous grain structure far superior to injection or transfer methods. There's no danger of "accordion joints" or partial knitting. Every LINEAR ROTO-MOLDED "O" Ring is uniformly perfect—built for complete dependability in your product.

You can get LINEAR ROTO-MOLDED perfect circle "O" Rings in a variety of standard sizes and compounds—or in special sizes and compounds to meet your requirements. Get the facts now!

"PERFECTLY ENGINEERED PACKINGS"

LINEAR

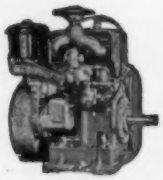
LINEAR, Inc., STATE ROAD & LEVICK ST., PHILA. 35, PA.



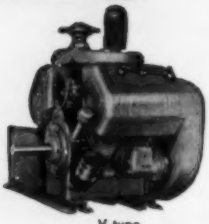
Consider the PRODUCER as well as the PRODUCT when you buy

ENGINES

4-cycle
Single Cyl.
3 to 9 hp.



2-Cylinder
Models
7 to 15 hp.



V-type
4-cylinder
15 to 36 hp.

Pictured above are the two large Milwaukee plants of Wisconsin Motor Corporation, which are devoted exclusively to the manufacture of Wisconsin Heavy-Duty Air-Cooled Engines.

The design and manufacture of thoroughly dependable engines such as these, is a highly specialized operation. In addition to comprehensive technical knowledge, engineering skill and modern manufacturing methods, it is important that the manufacturer have a broad, intimate knowledge of the *uses* to which the engines are put.

It is also highly desirable that the manufacturer should have large financial resources and world-wide distribution in order to assure the purchaser of a dependable source of supply at all times, for engines, original factory replacement parts and competent service.

You get all of these things and much more when you specify Wisconsin Air-Cooled Engines.

As the world's largest manufacturers of engines within a 3 to 36 hp. range, it is our responsibility to protect as fully as possible the best interests of our customers throughout the world. That is why we say "Consider the PRODUCER as well as the PRODUCT when you buy ENGINES".

We invite your inquiries.

WISCONSIN MOTOR CORPORATION
World's Largest Builders of Heavy-Duty Air-Cooled Engines
MILWAUKEE 46, WISCONSIN

HEYCO NYLON
STRAIN RELIEF BUSHINGS
anchor power cords to the housing & eliminate strain on terminals

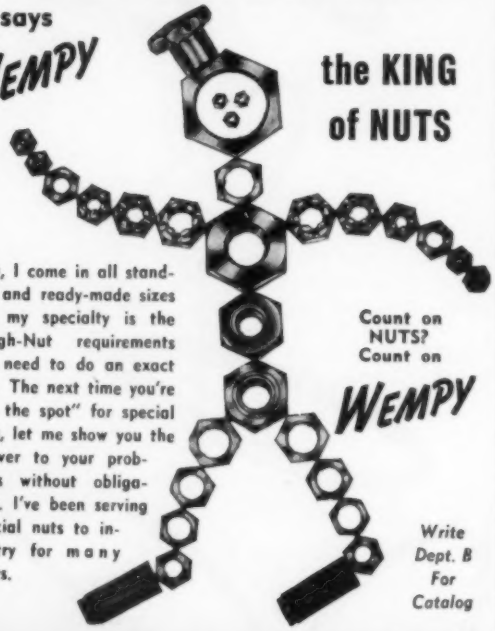
1. *Slip over wire*
2. *Snap into hole*

CUT PRODUCTION COSTS IMPROVE PRODUCT QUALITY

● Heycos absorb all cord pull, push and torque and insulate wire from housing. Product life is increased and product appearance is improved. Samples available on receipt of wire sizes.

HEYMAN MANUFACTURING COMPANY
KENILWORTH 3, NEW JERSEY

"The TOUGHER the BETTER" says WEMPY the KING of NUTS



Sure, I come in all standard and ready-made sizes but my specialty is the Tough-Nut requirements you need to do an exact job. The next time you're "on the spot" for special nuts, let me show you the answer to your problems without obligation. I've been serving special nuts to industry for many years.

Count on NUTS? Count on WEMPY

Write Dept. B For Catalog

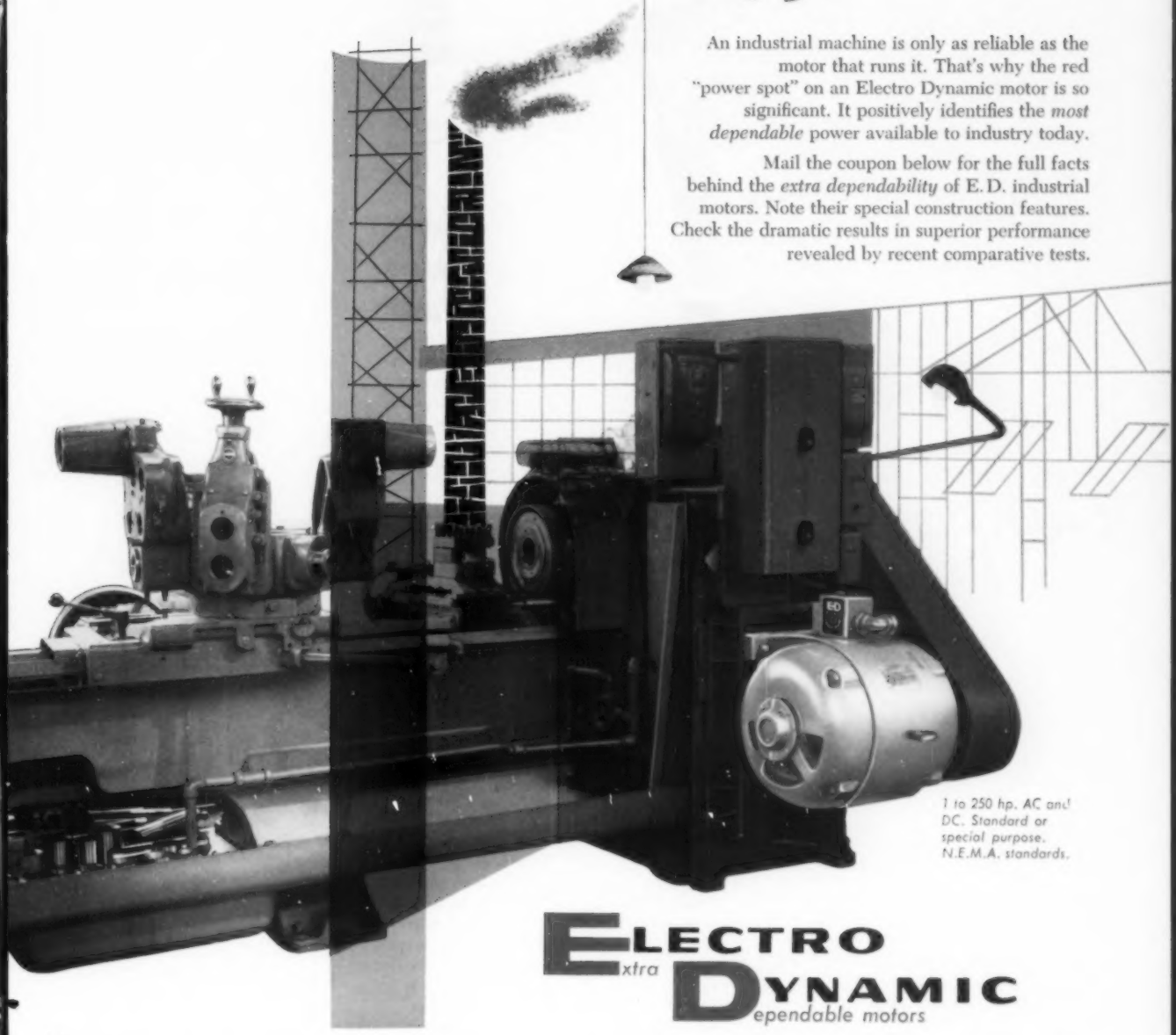
WESTFIELD METAL PRODUCTS CO., INC.
WESTFIELD, MASS

THIS EMBLEM MARKS
THE "POWER SPOT" ON
EXTRA DEPENDABLE MACHINERY

ED
ELECTRO DYNAMIC

An industrial machine is only as reliable as the motor that runs it. That's why the red "power spot" on an Electro Dynamic motor is so significant. It positively identifies the *most dependable* power available to industry today.

Mail the coupon below for the full facts behind the *extra dependability* of E. D. industrial motors. Note their special construction features. Check the dramatic results in superior performance revealed by recent comparative tests.



1 to 250 hp. AC and DC. Standard or special purpose. N.E.M.A. standards.

ELECTRO *xtra* **DYNAMIC**
ependable motors

ELECTRO DYNAMIC ***Division of General Dynamics Corporation***
179 Avenue A, Bayonne, New Jersey

- ☐ Elevators and building equipment
- ☐ Brewing and bottling
- ☐ Metal working
- ☐ Chemicals
- ☐ Air conditioning and refrigeration
- ☐ Meat packing and rendering
- ☐ Lumber, pulp and paper
- ☐ Mining
- ☐ Food processing and packaging
- ☐ Oil pumping and refining
- ☐ Tanning
- ☐ Textiles

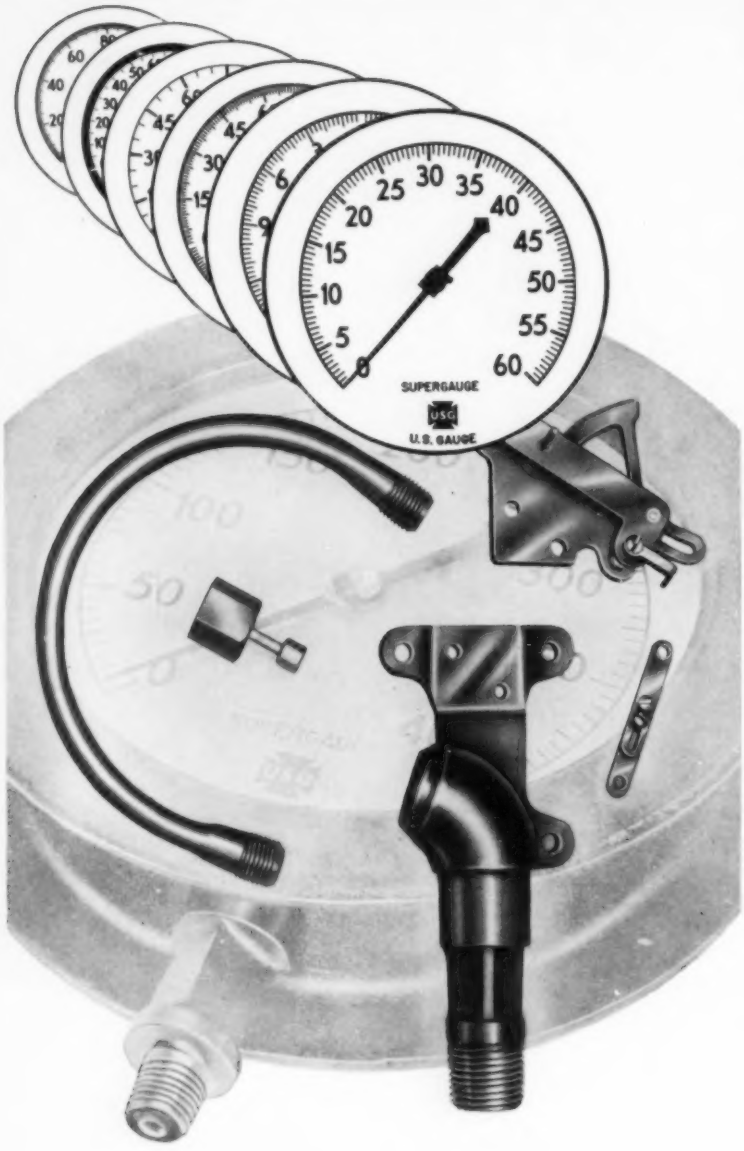
Other field not listed_____

Send literature on Electro Dynamic industrial motors for power applications in the industry checked at left to:

NAME_____

COMPANY_____

ADDRESS_____



A "special" that's standard

Special production of a gauge is expensive. Production of a special design is even more expensive.

USG helps you lower your gauge costs by stocking the world's most complete line of gauge components to meet almost every requirement of size, pressure, mounting, case and internals for all operating conditions.

For help with all your gauge and other pressure sensing and actuating devices, call your nearest USG District Office or write to us at Sellersville.

UNITED STATES GAUGE *Gauge Headquarters* FOR OVER 50 YEARS

United States Gauge, Division American Machine and Metals, Inc., Sellersville, Penna.

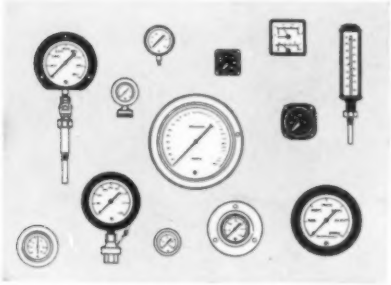
MANY USG STOCK GAUGES ARE "SPECIALS" WITH OTHER MAKERS

For over 50 years USG has been designing and producing gauges for more original equipment manufacturers than any other instrument company in the world.

Many of USG's "special" designs have become standard stock items in the industry. Many others that are "standard stock" at USG require expensive special production with other instrument manufacturers.

To meet special gauge requirements economically, USG maintains the world's largest stock of gauge components to meet any pressure sensing and actuating need.

In addition to these huge stocks for special designs, USG inventories over 200,000 standard gauges in a variety of types, sizes and ranges for practically every industry application.



To assure higher quality gauges with enduring accuracy, USG maintains the most rigid quality control system in the instrument industry. This rigid inspection system is supported by a Standards Laboratory with masters measuring from low vacuums to super pressures.

USG's facilities are economically integrated for large volume, quality controlled production, assuring better gauges—with enduring accuracy—*in every competitive price class.*

UNITED STATES GAUGE

ANNOUNCING

NEW

508

ROVING

... makes reinforced moldings better-than-ever!

Pittsburgh Fiber Glass Roving #508 is not just an ordinary roving. It's a new, different and definitely superior roving. It has been treated by a "special" sizing process to provide better chemical and mechanical bond between glass fibers and the actual molding resin.

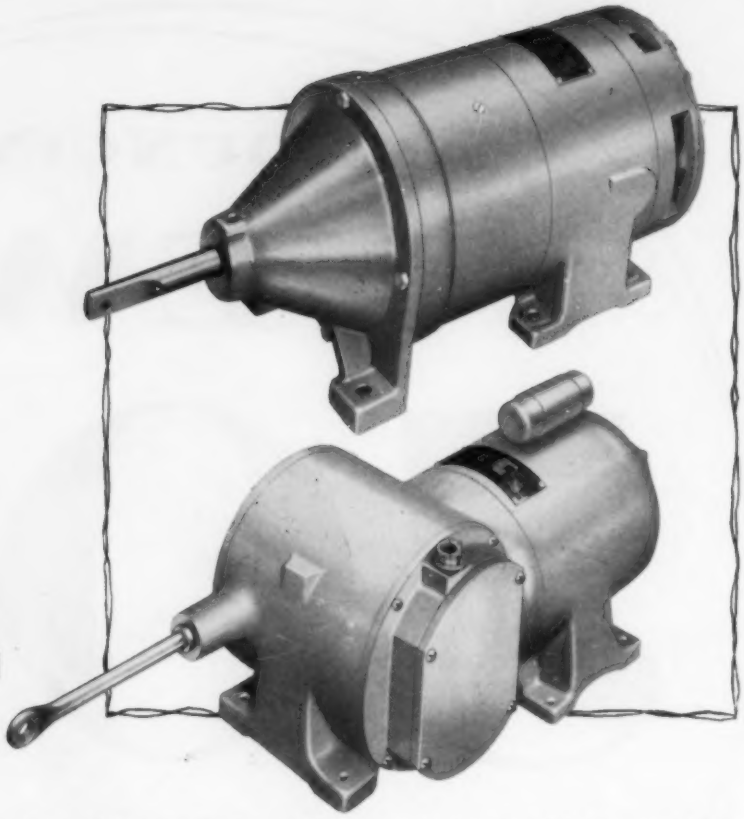
Because of this special treatment, Roving #508 outperforms other known types of rovings by producing consistently better preforms. In fact, *all* of the users of #508 report "excellent results."

If your products make use of reinforced plastics, it is suggested that you investigate the many advantages which may be obtained through the use of Pittsburgh Fiber Glass Roving #508. Complete information is readily available and we will be glad to give you data, including the names of molders now using this superior reinforcement. Just contact our executive offices or our district sales offices in Chicago, Cincinnati, Cleveland, Detroit, St. Louis, Houston, Los Angeles, New York or Philadelphia. Pittsburgh Plate Glass Company, Fiber Glass Division, One Gateway Center, Pittsburgh 22, Pennsylvania.

FIBER PPG GLASS

PAINTS • GLASS • CHEMICALS • BRUSHES • PLASTICS

PITTSBURGH PLATE GLASS COMPANY



$500.00 CASH

to the engineer who tells us the Most Practical Application for this NEW PUSH-PULL MOTOR

Wesche special motor engineers have created a monster. It's a motor whose power is transmitted in terms of linear thrust with force of from 100 to 10,000 pounds.

When these hairy eared engineers unveiled their handiwork to our sales and advertising brains, we said, "Swell, what's it good for?" Nearly every answer we got was qualified by "I think" or "maybe."

This being a state of affairs unique in our experience, we decided that if we can't *tell* you how to use it, we'll *ask* you and pay for the best answer.

HERE'S THE DOPE

We have two kinds of Thruster Motors. One supplies a reciprocating straight line motion with no reversal of the motor needed for a full cycle. In the other type the reversal of thrust is obtained by reversing the motor. Both types can be equipped with brake and electrical controls to stop and hold at any part of cycle.

The length of stroke and speed of cycle can be widely varied to the specific requirement.

In submitting your idea for use of this motor, name the type of machine to which you believe it can be applied, and the specific operation it can perform.

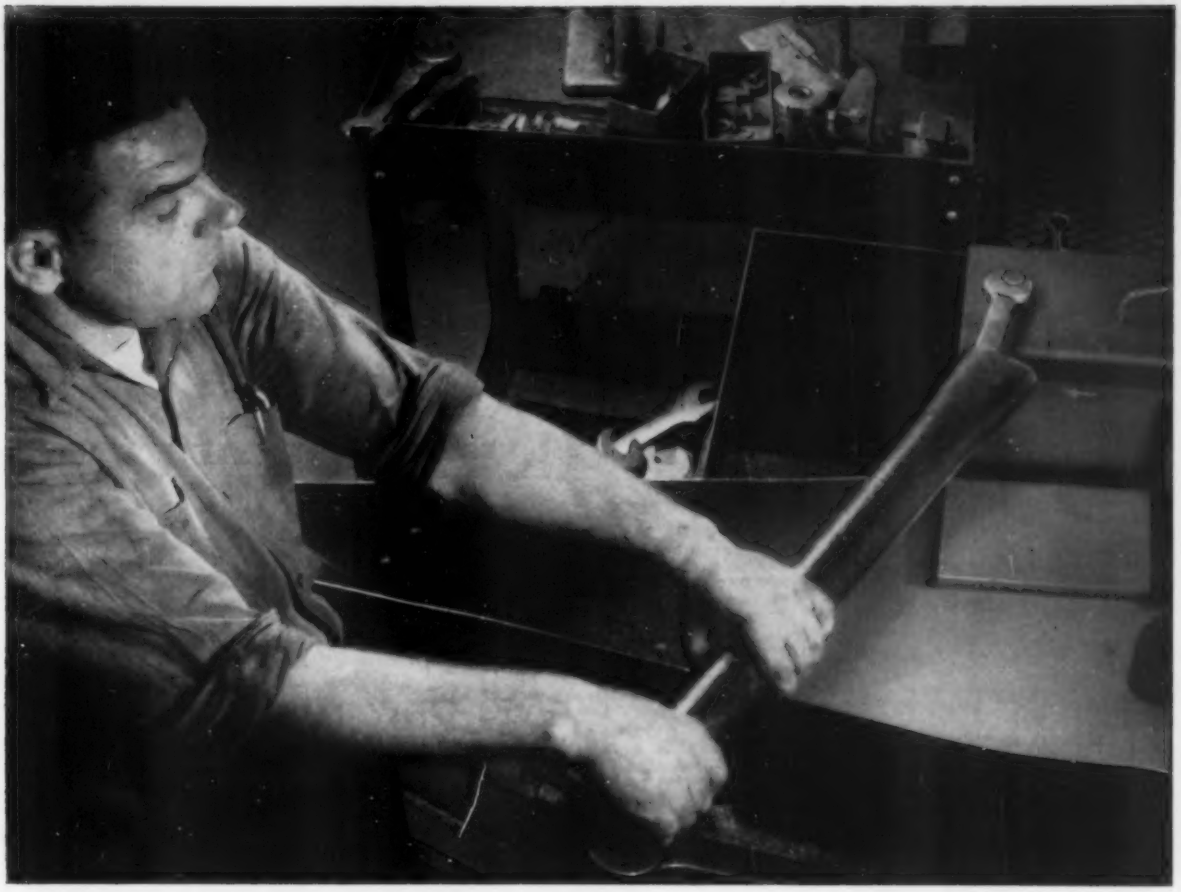
The $500 winner will be the engineer whose suggested use is deemed most practical from a standpoint of potential sales by the Wesche Sales Department. In event of ties, the $500 will be split between all submitting the winning answer. No entries will be returned and all become the property of this company. Entries must be postmarked before Nov. 1, 1954.

If your thinking on this matter leads you to a possible application in your own work, it will not be purely coincidental. We planned it that way.

THE B. A. WESCHE ELECTRIC COMPANY

1624 VINE ST., CINCINNATI 10, OHIO

torque motors
special motors
collector rings

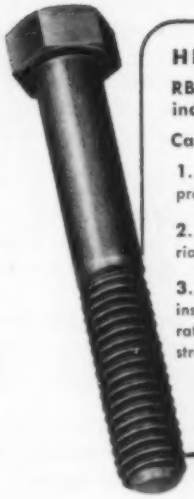


Sure, you'd need special cap screws here!

Some people have strange ideas on tightening cap screws.

Like the manufacturer we ran across recently. His workmen tightened cap screws far beyond their load limit as a matter of course. Naturally, this caused costly screw failures in the field. Also naturally, the boss figured the only way out was to buy expensive special screws with higher physical properties. Just in time, a sharp-eyed RB&W "fastener engineer" pointed out that a high-quality standard RB&W cap screw could do the same job — if the tightening method was corrected.

This incident spells out a cost-saving story for every user of fasteners. Maybe there's a stage in your operation where you're using a fastener designed for a bigger job than you're giving it. So it's important for you to know that an RB&W *standard* screw, nut or bolt can often give you the same dependable service you're paying extra for now. The facts in the box at right make it well worth a phone call to the nearest RB&W office to find out how these very special standards can do a job for you. RUSSELL, BURDSALL & WARD BOLT AND NUT COMPANY, Port Chester, N.Y. 4.4



HERE'S WHY...

RB&W standards often surpass industry standards.

Cap screws, for example:

1. They're cold-headed — the process that produces the best bolts and cap screws.

2. Cold-heading requires superior materials — resulting in sounder products.

3. Modern equipment and quality control insures precise sizes, superior finish, accurate threading — for fast assembly and stronger end products.

4. RB&W cold-heads the widest size range in industry.

RB&W **RUSSELL, BURDSALL & WARD**

109 YEARS MAKING STRONG THE THINGS THAT MAKE AMERICA STRONG

Plants at: PORT CHESTER, N.Y.; CORAOPOLIS, PA.; ROCK FALLS, ILL.; LOS ANGELES, CALIF. *Additional sales offices at:* ARDMORE (PHILA.), PA.; PITTSBURGH; DETROIT; CHICAGO; DALLAS; SAN FRANCISCO. *Sales agents at:* SEATTLE. *Distributors from coast to coast.*

THE PACKAGING INDUSTRY, TOO, RELIES ON UE CONTROLS

UE Type E46
Model 62 Thermostat

The development of self-service departments virtually demanded the use of transparent bags—of cellophane, pliofilm, polyethylene and similar materials. But making containers from these materials created a problem: how to seal the folds accurately, quickly and permanently?

Simplex Packaging Machinery, Inc., solved this problem with heat sealing. It developed an exclusive, adjustable stop-and-seal cycle that assures dependable sealing of every bag, no matter what type or size.

United Electric's Type E46 Model 62 Thermostat, developed especially to solve Simplex's problem, provides the critical temperature control required in this cycle. It helps eliminate pin holes and burnt spots, and assures longer, stronger seals.

United Electric manufactures a wide line of standard controls that are used in aircraft fuel purging systems, paper mill machinery, diesel engines, milk pasteurizers, room air conditioners and in countless other applications.

Special controls can be adapted from standard models, or can be custom-built by United engineers working in cooperation with your own product development engineers.

Write today for information on the complete line of United Electric controls.

Standard and special thermostats and pressure switches

UNITED ELECTRIC CONTROLS CO.
87 School Street, Watertown, Mass.

How to keep informed on the "with what" part of your business

AT YOUR FINGER TIPS, issue after issue, is one of your richest veins of job information – advertising. You might call it the "with what" type – which dovetails the "how" of the editorial pages. Easy to read, talking your language, geared specifically to the betterment of your business, this is the kind of practical data which may well help you do a job quicker, better – save your company money.

Each advertiser is obviously doing his level best to give you helpful information. By showing, through the advertising pages, how his product or service can benefit *you* and *your* company, he is taking *his* most efficient way toward a sale.

Add up all the advertisers and you've got a gold mine of current, on-the-job information. Yours for the reading are a wealth of data and facts on the very latest in products, services, tools . . . product developments, materials, processes, methods.

You, too, have a big stake in the advertising pages. Read them regularly, carefully to keep job-informed on the "with what" part of your business.

McGRAW-HILL PUBLICATIONS

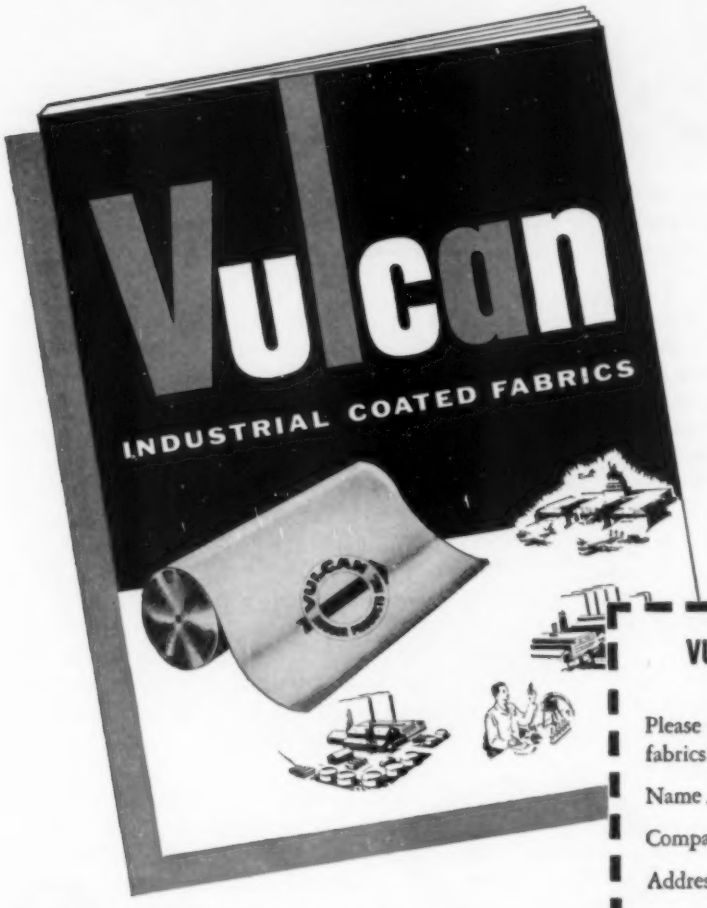
DESIGNERS, ENGINEERS:
HERE'S A HANDY CATALOGUE YOU'LL ALWAYS BE USING!

If your work includes the use of natural and synthetic rubber coated fabrics, you'll find the new Vulcan catalogue indispensable. It will serve as a convenient table-side reference to give you the details quickly on the great diversity of Vulcan fabrics available. Useful specification data answers your questions *right now!* Send in the coupon today for your copy.

Vulcan coated fabrics are the modern materials for—

- Air seals
- Bearing seals
- Cable wrapping
- Carrying cases
- Carburetors
- Control diaphragms
- Covers and paulins
- Fuel containers
- Fuel pump diaphragms
- Gaskets
- Hospital sheeting
- Insulation
- Meter diaphragms
- Railroad car seals
- Regulators
- Safety clothing
- Soundproofing
- Transmission seals
- Vacuum pumps

Many of the items for the above uses are produced to meet the specifications of AMS 3270, AMS 3274-A and MIL. C 8068 Type I



Manufacturers of Vulcan-Duroflex products
A subsidiary of Reeves Bros. Inc.

VULCAN RUBBER PRODUCTS, INC.
54 Worth Street, New York 13, N. Y.

Please send your new Catalogue of industrial coated fabrics to:

Name _____

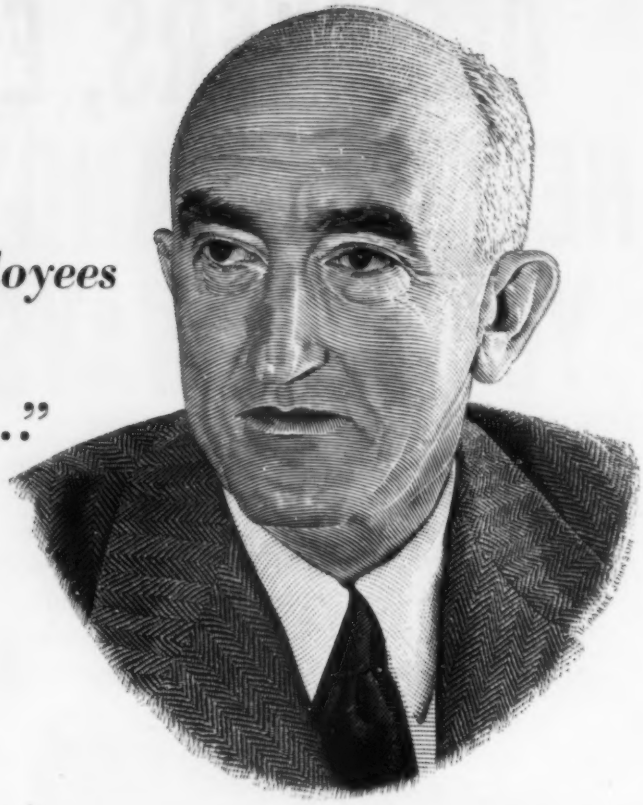
Company _____

Address _____

_____

P-9

"Boeing's 59,000 employees feel closer to the company..."



WILLIAM M. ALLEN
President
Boeing Airplane Company

"Boeing's 59,000 employees feel closer to the company since our recent successful person-to-person payroll savings drive in the Seattle and Wichita Divisions. Through letters and personal observations many employees have told us they have a greater sense of being a part of the company—that Boeing is interested in the welfare of each and every man and woman on the payroll."

That's the way it is with Payroll Savers. With the realization that systematic investment in U. S. Savings Bonds is a sure road to the down payment on a home, comfortable retirement, or other objectives, comes a better appreciation of a man's job and his company.

To most Payroll Savers, a day's absence from work means just that much out of his take-home savings. And he no longer takes chances, because he wants to stay off the accident list. He looks for better and quicker ways to do his job—promotion will mean more dollars for Savings Bonds. As a stockholder in America he takes a better interest in national affairs, the sound dollar, and economic stability.

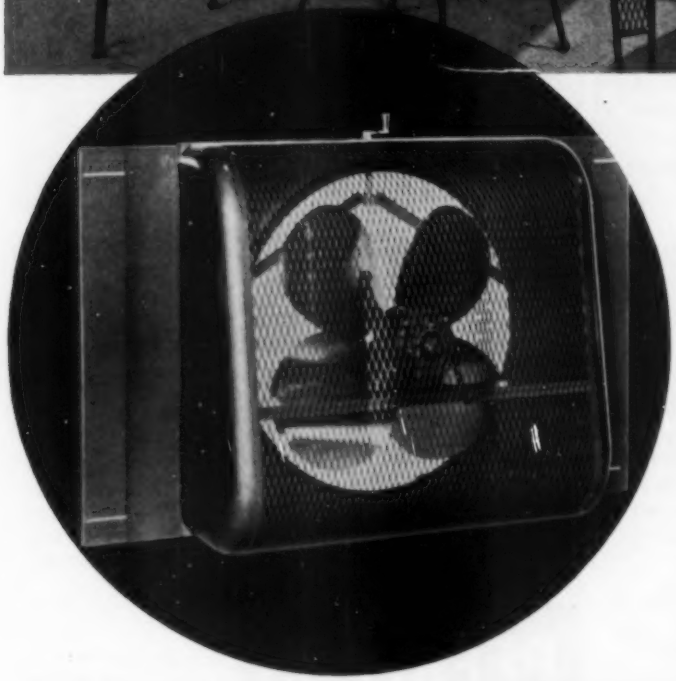
91% of Boeing's 65,000 employees—more than 59,000 men and women—are Payroll Savers, as a result of a person-to-person canvass that put a Payroll Savings Blank in the hands of every Boeing employee. Certainly that is a high percentage of which Mr. Allen may well be proud. But it is not exactly unique. A number of the 45,000 companies which have the Payroll Savings Plan have 90% participation; many are in the 80% to 90% group, and many more are in the 60%, 70%, 80% class. In every case, these high percentages followed a person-to-person canvass that put a Payroll Savings Application Blank in the hands of every employee.

If less than 60% of your employees are Payroll Savers, do something about it. A phone call, telegram or letter to "Savings Bond Division, U. S. Treasury Department, Washington, D. C.," will bring prompt assistance from your State Director, U. S. Treasury Department. He will help you install, or revitalize a Payroll Savings Plan, through a simple, person-to-person canvass which your employees will be glad to conduct.

The United States Government does not pay for this advertising. The Treasury Department thanks, for their patriotic donation, the Advertising Council and

PRODUCT ENGINEERING

For that smart, clean, attractive look use EXPANDED METAL



The window ventilating fan is a product of Atlas Tool & Manufacturing Company, St. Louis, Mo.

Furniture made by Duro Chrome Corporation, St. Louis, Mo.

PM-48

The use of Penmetal expanded metal improves almost any product. For example:

Furniture—Flattened expanded metal, painted or enameled is widely used in furniture construction both for utility and for decoration. Not only strong and light in weight, it is also attractive in appearance.

Fans—Penmetal expanded metal provides a safe, sure guard for fans, yet permits free passage of air. The symmetrical diamond pattern adds beauty to the design.

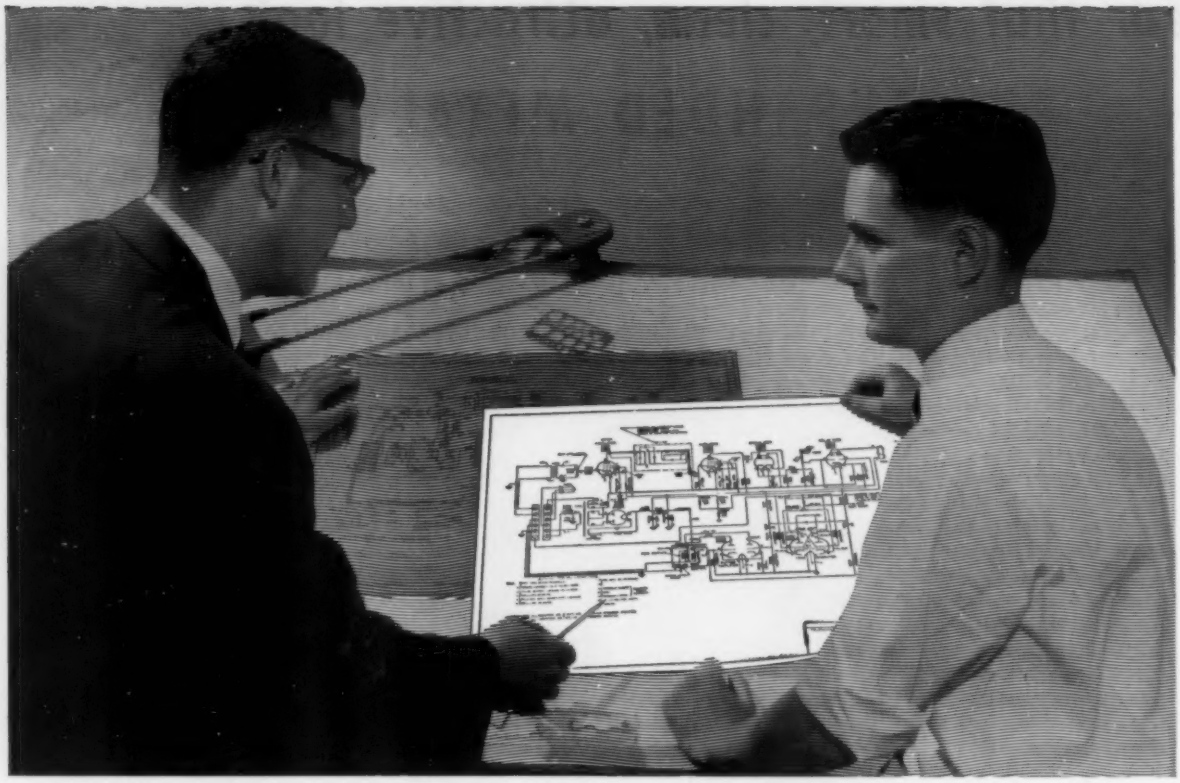
Penmetal expanded metal is sheet metal that has been slit and expanded to as much as ten times its original width. Available in carbon steel, aluminum, stainless steel, Monel, Inconel, and other metals; large or small mesh; light or heavy gauge.

Send for *New* 28-page catalog which gives mesh sizes, weights and dimensions, and shows many profitable ways in which you can use Penmetal expanded metal. No cost or obligation.

PENN METAL COMPANY, INC.

General Sales Office:
205 East 42nd Street, New York 17, N. Y.

District Sales Offices:
Boston, Philadelphia, Parkersburg (W. Va.), Detroit, Chicago, Dallas, Los Angeles, San Francisco, Seattle



Here's why

Peerless Cloth gives you faultless reproduction...

VERY HIGH IMAGE DENSITY: The high silver content of the emulsion, made to Peerless' own formula and carefully quality-controlled, gives deep rich blacks and good clean whites in striking contrast. Copies linework sharply and clearly, including very fine pencil lines. Reproduces all letters and numerals without filling.

GREATER TRANSLUCENCY: The highly transparent base fabric, obtained by friction-calendering fine quality long-staple cotton cloth, is made evenly translucent by applying a waterproof plastic coating. Translucency is carefully checked for uniformity over the entire area and from roll to roll. Result is clear, sharp reproductions by either blueprinting or the diazo process.

BETTER WEARING PROPERTIES: Peerless Cloth is more flexible, won't crease or crack or abrade even under severe handling. Doesn't curl up at the edges no matter how many passes it makes through the printer. Erases easily, has a good tooth for redrawing after eradication, and takes ink readily without feathering. Extremely high bond-strength insures that neither the emulsion nor the sub-coating will peel from the base cloth during processing.

Peerless Cloth is available in white or in blue, coated with either Tru-Flex standard-speed emulsion or Projection high-speed emulsion. Its quality is carefully checked at each of 46 manufacturing operations.

PEERLESS PHOTO PRODUCTS, INC. PE-9
Shoreham, L. I., New York

Please ask your distributor nearest me to send me a sample of Peerless Reproduction Cloth.

☐ TRU-FLEX ☐ PROJECTION

NAME _____

COMPANY _____

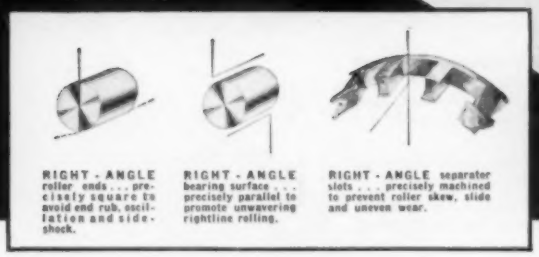
ADDRESS _____

PEERLESS
Reproduction
CLOTH

Your Peerless distributor will be glad to supply samples of Peerless Cloth to test in your own plant. Call him, or mail the coupon at left.

UNWAVERING ORBITAL ROTATION

Because every surface is precisely square . . . precisely parallel. No skew . . . No skid . . . No oscillation



RIGHT - ANGLE roller ends . . . precisely square to avoid end rub, oscillation and side-shock.

RIGHT - ANGLE bearing surface . . . precisely parallel to promote unwavering rightline rolling.

RIGHT - ANGLE separator slots . . . precisely machined to prevent roller skew, slide and uneven wear.

ROLLWAY right-angle solid cylindrical roller bearings

Loaded at right angles, with no diagonal components to impose skew forces. Precisely square and parallel from every surface aspect. The solid cylindrical rollers of Rollway Right-Angle Roller Bearings follow the right-line motion of Newton's first law, providing *unwavering orbital rotation around the shaft.* Internal friction and heat are held to a minimum. Maintenance attention and replacement costs are low . . . life and load-performance qualities surprisingly high.

Our engineers will gladly assist you in selecting the best bearing for your particular needs. Complete engineering and metallurgical services are always at your command. No cost. No obligation. Just write or wire. Rollway Bearing Co., Inc., Syracuse, N. Y.

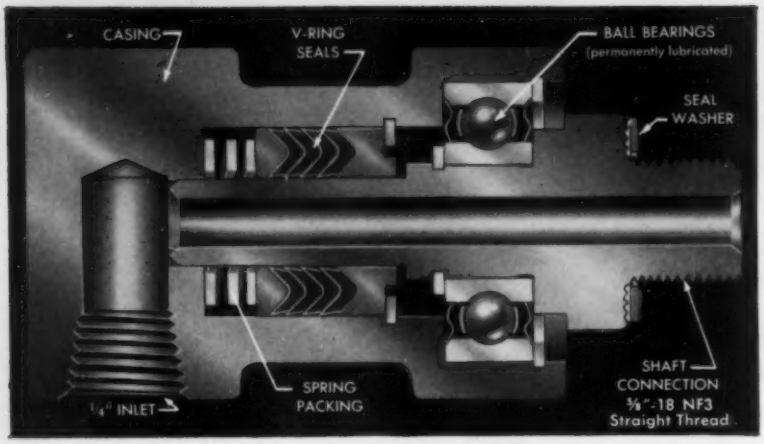
ROLLWAY BEARINGS

COMPLETE LINE OF RADIAL AND THRUST CYLINDRICAL ROLLER BEARINGS

SALES OFFICES: Syracuse • Chicago • Toronto • Cleveland • Seattle • Philadelphia • San Francisco • Boston • Detroit • Pittsburgh • Milwaukee • Houston • Los Angeles

BARCO

A New ¼" REVOLVING JOINT



For High Speed, Rotating Piping Connections

■ This new Barco TYPE NV Revolving Joint is designed for use wherever you need high speed, *low torque*, leakproof rotary connections for air, hydraulic, or coolant lines on machine tools and other equipment.

NO LUBRICATION NEEDED—Sealed ball bearings are lubricated for life.

LEAKPROOF—Barco's V-ring seals have been proven in use for many years. Self-adjusting for wear.

CLOSE FITTING—¼" I. D. rotating shaft has ⅜" 18 NF3 straight threaded end which insures concentricity. Seal is made against the square shoulder on the rotating shaft drawn tightly, with a sealing washer, against the square face of rotating part.

PRECISION-BUILT—All parts machined to close tolerances. Bronze casing; hardened and ground steel shaft. Parts interchangeable and easily renewable.

SMALL, COMPACT, ECONOMICAL—Easy to install where space is limited. Overall length, 3⅜".

WIDE SPEED RANGE—Up to 2500 RPM. For pressures to 300 psi (air) or 1500 psi (hydraulic). Temperatures to 180° F. *Send for complete information.* BARCO MANUFACTURING CO., 527K Hough St., Barrington, Illinois.

Typical Applications

- Machine Tools
- Air, Hydraulic Clutches
- Power Transmission Drive Units
- Air Operated Chucks
- Spindles, Grinding Wheels
- Water and Air Brakes

ASK FOR BULLETIN No. 307

Barco Builds a Complete Line of Revolving Joints—Ask for Catalog 300.

DESIGNERS

for layout and design of electronic and mechanical components of radar systems and computing equipment.

1
THE COMPANY

Hughes Research and Development Laboratories form one of the nation's leading electronics organizations. The Laboratories are presently engaged in development of advanced electronic systems and devices produced by the Hughes manufacturing divisions.

2
AREAS OF WORK

The work calls for layout and production design of: 1. Reliable, maintainable electronic units. 2. Unique electromechanical devices. 3. Installations of electronic equipment in interceptor airframes.

Relocation of the applicant must not disrupt an urgent military project.

3
THE FUTURE

Designers experienced in the field of electromechanical design for production, or those interested in entering this field, will find outlets for their abilities and imagination in these active areas. New electromechanical techniques are opening new applications of airborne electronic equipment. Hughes designers will have the benefit of working experience in these fundamental developments.

Scientific and Engineering Staff

HUGHES

RESEARCH AND DEVELOPMENT LABORATORIES

Culver City, Los Angeles County, California

OUTSTANDING PROPERTIES IN JOHNSON ALUMINUM-ON-STEEL BEARINGS
THE design trend to more horsepower in internal combustion engines calls for the higher load capacity of Johnson Aluminum-on-Steel Bearings. Heavy duty diesel and gasoline engine builders have found them to be highly satisfactory. These bearings combine some of the properties of babbitt-on-steel with those of higher strength aluminum alloy, permitting bearing loads up to 5,000 P.S.I. They offer good conformability, good resistance to shaft wear, good corrosion resistance, adequate seizure resistance, and good resistance to fatigue. These are properties which design engineers have been looking for. Wherever high-load, high speed bearings are required, investigate Johnson Aluminum-on-Steel. Write for information.
JOHNSON BRONZE COMPANY
805 South Mill Street, New Castle, Pennsylvania
JOHNSON BRONZE PRODUCES ALL TYPES OF SLEEVE BEARINGS:
BRONZE-ON-STEEL, copper lead • STEEL BACK, babbitt lined • BRONZE BACK, babbitt lined • CAST BRONZE, plain or graphited • SHEET BRONZE, plain or graphited • CAST ALUMINUM ALLOY • ALUMINUM-ON-STEEL • LEDALOYL powder metallurgy
JOHNSON JB BEARINGS
Sleeve-Type

SPECIALS may match the prices of STANDARDS

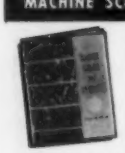
If ordered in fair quantities, recessed hex head screws cost no more than standard machine screws, and actually much less than trimmed hex head screws.

The saving results from elimination of one production operation, without loss of mechanical values. The difference is in appearance. And even that may be in favor of the recessed head.

To order only, made to standard dimensions in sizes to suit your needs or to your specifications.

Get our prices and deliveries on your requirements. In fact write us about special upset, and rolled thread products of any kind. The cost may be lower than you think.

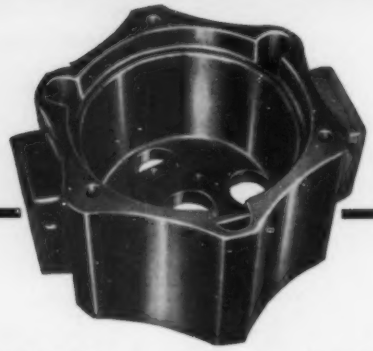
MACHINE SCREWS AND SPECIAL FASTENERS ARE OUR BUSINESS



WRITE FOR OUR CATALOG

THE PROGRESSIVE MANUFACTURING COMPANY
48 NORWOOD ST., TORRINGTON, CONN.

WE MAKE THE KIND OF INSULATORS YOU NEED!



Universal Porcelain Insulators are custom made, exactly to the dimensions and the required performance specified . . . in any quantity desired. High resistance to shock is an outstanding feature of all Universal Insulators. Additional advantages include high dielectric strength, resistance to flash over; ability to withstand moisture, fumes, acids, heat and cold. Your inquiry will receive our prompt attention.

THE UNIVERSAL CLAY PRODUCTS CO.
1545 EAST FIRST STREET (U) SANDUSKY, OHIO
TRADE MARK

New small counters of GREAT RELIABILITY

Shaft extension at right with rigid steel arm

Shaft extension at left with spring steel arm

Ideal for Built-in Application

- Endurance tested for accuracy to over 100 million counts.
- Small, compact, rugged construction. Main body only $1\frac{43}{64}$" x $1\frac{43}{64}$" x $1\frac{7}{16}$" high.
- Reset to zero with one complete turn of reset knob.
- Slotted holes for easy mounting.
- Steel case and frame with enduring chrome plated finish.
- Furnished with rigid or flexible operating arm, right or left shaft extension, top-coming or top-going arm action.

SEE, COMPARE and TEST the new Junior King. Ask your PIC Representative or write.

Complete catalog mailed on request

PRODUCTION INSTRUMENT COMPANY
702-10 W. Jackson Blvd., Chicago 6, Ill.

Tandem-rotored six-place craft with large rescue hatch. Its mission — search and rescue; utility transport.

SAVE YOURSELF

from costly, excessive wear

...with AMPCO* METAL

Piasecki Helicopter Corporation
Morton, Pennsylvania

Problem: To find a material that withstands severe shock loads, high operating speeds, corrosive action of the elements and, at the same time, provides good bearing qualities when needed for such parts as:
Dowel—Rotor Blade Leading Edge, Bushing—Trim Mechanism, Bearing—Collective Pitch Lever Flange, Bearing—Collective Pitch Lever Grip, Bushing — Flexible Shaft Coupling, Support Assemblies — Power Plant Controls, Fuel Shut-Off, Swivel Details, Washer—Rescue Hatch Actuator, and many other components.

Solution: AMPCO METAL

Results: The performance of Piasecki helicopters under all kinds of conditions is proof of the life-saving dependability of these units. The ability to "take it" has established Piasecki as a leader in the development of transport helicopters.

IT'S PRODUCTION-WISE TO AMPCO-IZE

HERE are the properties of Ampco Metal that appeal to designers and plant-operating men -- properties that increase the service life of machines, and reduce upkeep costs:

High compressive strength — Ampco Metal doesn't squash out . . . High resistance to corrosion, erosion, and abrasion . . . High impact and fatigue values . . . Excellent bearing qualities.

Because Ampco Metal has this ability to stand up under the severest kind of service, leading companies, like Piasecki Helicopter Corporation, use this outstanding aluminum bronze alloy to provide an extra margin of safety and dependability.

If you have a wear problem in either product or plant, investigate the cost-saving properties of Ampco Metal. You can get it in practically any form you need — sheet, plate, sand and centrifugal castings, forgings, bars, tubes, welding wire and electrodes. For further information consult your nearest Ampco field engineer or send this coupon.

*Reg. U. S. Pat. Off.

Ampco Metal, Inc.
MILWAUKEE 46, WISCONSIN
West Coast Plant:
BURBANK, CALIFORNIA

MAIL COUPON TODAY

Ampco Metal, Dept. PE-9, Milwaukee 46, Wisconsin

Send me your free Ampco Metal literature giving descriptions and general applications of Ampco Metal.

Name..... Title.....

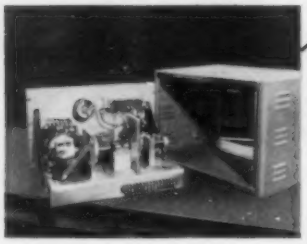
Company.....

Address.....

City.....(.....) State.....

D-12A

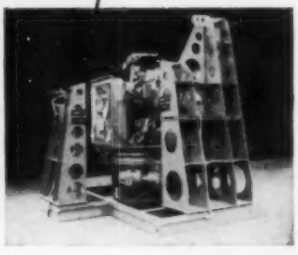
from
DRAWING BOARD
to
FINISHED PRODUCT
under one roof!



SERVO ANALYSIS NETWORK

ANGULAR POSITION TRANSMITTER

POTENTIOMETERS —precision linear and non-linear



GUN DIRECTOR—being optically aligned.

Serving the Armed Forces and Industry in the research, development, design and manufacture of electronic, electrical, electromechanical and mechanical devices—DAYSTROM INSTRUMENT has a full range of up-to-date equipment for production from raw materials to finished assemblies and systems. *Under one roof* their 350,000 sq. ft. plant has facilities available to meet every need for internal, external, surface and centerless grinding; low to high precision turning; jig boring and milling; welding, heat treating and finishing; spur and helical gear shaping; hobbing and shaving; straight and spiral bevel gearing; test and inspection, facilities and know-how for the entire range of production.

Division of Daystrom, Incorporated

DAYSTROM INSTRUMENT

ARCHBALD, PENNSYLVANIA

AFFILIATES:
American Type Founders, Elizabeth, N.J.
Daystrom Furniture Div., Olean, N.Y.
Daystrom Electric Corporation Poughkeepsie, N.Y.

FOR Quality Performance from
WIRE FORMS
SPRINGS
METAL STAMPINGS
Rely on
DUDEK & BOCK
You get precision WIRE FORMS, Springs and Stampings that are easily assembled . . . that withstand stresses . . . perform under the most *trying* conditions. Rely on our free designing service. Our EXPERT ENGINEERS will produce designs that meet your *exact* needs—and save you MONEY!
Valuable FREE Brochure
SPEEDY DELIVERY
WRITE—WIRE or PHONE
for Estimates and Delivery Dates
Phone:
HAymarket 1-1880
DUDEK & BOCK
SPRING MFG. CO.
2100 W. Fulton, Chicago 12, Illinois

Engine Manufacturers:

CUT YOUR INSTRUMENT COSTS 1/2

ONE Murphy Safety Switch serves as accurate indicating instrument AND provides accurate, automatic protection for your internal combustion engine.

No Gauges to Buy and Install.

MODEL 0-27 Automatically stops engine if oil pressure system fails. Mount on your instrument panel or screw direct into oil line. Visible contacts and pressure gauge both in one instrument.

CUT INSTRUMENT COSTS IN HALF ON BATTERY OR MAGNETO IGNITION AND DIESEL ENGINES

MODEL SR-21 Fully automatic high water temperature safety switch and temperature indicator. Mount on your instrument panel or screw direct into water jacket.

Over A Million MURPHY SAFETY SWITCHES Are Now In Service.

Write for information for standard or made-to-order panels for O.E.M. accounts.

FRANK W. MURPHY *Manufacturer*
BOX 1476 TULSA, OKLA.
BRANCH: LOS ANGELES 41, CALIFORNIA

One flow control does the work of nine

Denison Multi-Range Flow Control
Infinitely adjustable for any delivery without changing spools

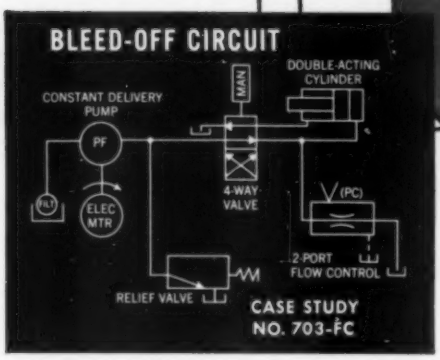
One dial now controls flow for as many as nine different ranges . . . assures accurate rate of flow . . . often eliminates need for a variable-volume pump.

With Denison Multi-Range Flow Control, there's no need to change valves or spools. If pump delivery is changed, simply turn the dial.

Available in ¼, ⅜ and ¾-inch port sizes. For any circuit to 3000 psi. Capacities to 28 gpm.

Subplate-mounted, Denison Multi-Range Flow Controls come in 2-port and 3-port types . . . with or without built-in check valves. The 3-port type meters flow to the work and diverts excess to tank.

The bleed-off circuit shows a Denison Flow Control regulating cylinder speed. For bulletins about Denison Multi-Range Flow Controls, write to: THE DENISON ENGINEERING COMPANY, 1194 Dublin Road, Columbus 16, Ohio.



DENISON Hydr OIL ics

PUMPS • MOTORS • CONTROLS • PRESSES

REPUBLIC "LO-TORQ" SELECTOR VALVE

0-6000 psi SERVICE with LOW TURNING TORQUE

Exceptionally low turning torque is obtained by "floating" the valving disk in the service fluid, thereby balancing the pressure and eliminating thrust bearings . . . a sound application of the hydraulic engineering principle that fluids under pressure exert force equally in all directions.

Sealing rings on both sides of the selector disk eliminate leakage at all times whether pressure is forward, back, or off entirely.

For air and gas service, 0-1000 and 0-3000 psi; for fuel, hydraulic oil, petroleum, and water service, sizes ⅛" to 1", 0-2000 and 0-6000 psi. 2, 3, and 4-way.

Write for catalog no. 454 for complete information.

Distributors in principal cities from coast to coast.

- 0-6000 psi service
- Low turning torque
- Panel mounting
- Semi-steel, bronze, aluminum alloy
- No leakage at any time
- 3 types of portings

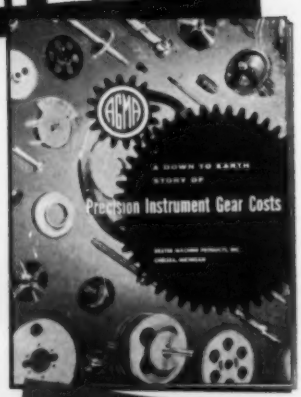
130

RM

REPUBLIC MANUFACTURING CO.

15655 BROOKPARK ROAD • CLEVELAND 11, OHIO

GEAR COSTS ANALYZED



Every gear buyer will be interested in this eight page folder entitled "A Down-to-Earth Story of Precision Instrument Gear Costs."

Every element of gear cost is discussed. Each operation in the production of the four grades of "Commercial" and the three grades of "Precision" gears are evaluated in minutes of labor for direct cost comparison.

YOUR COPY IS READY WRITE FOR IT TODAY

6964

Dexter MACHINE PRODUCTS, INC.
20466 U. S. 12 WEST
CHELSEA, MICHIGAN
Phones: Detroit, WO. 5-2399—Chelsea, GReenwood 2-1791

Facts about

Product Engineering

Product Engineering **is the only paid-circulation magazine serving design engineers.**

LEFAX POCKET SIZE TECHNICAL DATA BOOKS $1.25 EACH

Printed on loose leaf, six hole, 6-¾" x 9-¾" bond paper, each book contains about 140 pages of technical data, presenting condensed, accurate and essential data for the engineer, technical worker and business man.

Architecture	Building Constr.	Piping Data
Home Heating	Radio	Surveying Tables
Illumination	Television & FM	Trig-Log Tables
Electrician's Data	Electricity, AC	Metallurgy
Builder's Data	Electricity, DC	Analytic Chemistry
Lumber Data	AC motors and Generators	Highway Engineering
Air Conditioning	Transformers, Relays, Meters	Mech. of Materials
General Math.	Hydraulics	Pwr. Trans. Mchy.
Math. Tables	Surveying	Thermodyn. Tbls. & Charts
Physics	Mech. Drawing	Phys. & Thermodyn. Data
Chemical Tables	Machine Design	Phys. & Org. Chem.
Metals	Machinists Data	
Gen'l. Chemistry		
Reinf. Concrete		

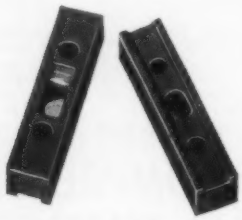
Write for FREE catalog (over 2000 listings). See for yourself how helpful LEFAX can be to you. Send $1.25 for each book, or $6 for only five books listed above, to:

LEFAX DEPT. PE-5 Philadelphia 7, Pa.

Making this intermediate wringer-drive gear of iron and copper powder saves the Whirlpool Corporation, St. Joseph, Michigan, up to $20,000 per year. The part was formerly made from a ⅜" blank which was pierced, flattened, machined for teeth; wire brushed for burr. Tolerances on the powder metal part are identical with those by machining.

The part shown is a card register block for IBM machines. Close dimensional tolerances are required as the part is used in a precision machine. The screw holes are tapped. As compared with machining the part represents a saving of approximately 82% in cost!

A valve disc sleeve used in the air release mechanism of a Neptune Red Seal petroleum meter was originally made of brass rod stock, then of die-cast zinc (which proved unsatisfactory) and now of powdered brass. Corrosion resistance is adequate; tolerances are ±.001" on two diameters. The part costs no more than the unsatisfactory die casting; approximately ⅓ that of the machined part.



Here are shown top and bottom of a powdered iron block that forms the structural base for the shearing head of a Schick Electric Razor. Dimensional stability is an important requirement. Powdered iron — replacing SAE 1020 steel bar stock—saves 7 machine operations and effects a saving of 50% in cost.

For Parts Like These... Powder Metal is a BIG Economy

Parts with involved contours that require multiple shaping operations . . . parts which cause heavy scrap losses . . . should be made of powder metal.

Brass, bronze, and iron powders, or mixtures, make powder metal parts at a single stroke to close tolerances . . . with coining to ±.001" . . . to tensiles of 70,000 psi . . . as high as 100,000 psi or more for special applications.

Stokes makes the presses that make the powder metal parts . . . offers you the experience of over 30 years in setting up for this modern, low-cost high-production method.

F. J. Stokes Machine Company, Philadelphia 20, Pa.

Another IBM part: This oil pump rotor is used in several IBM machines. Saving in cost as compared with a machined part, says IBM, is 84%! Total tolerances of .001" and .002" are required. Powder metal processing eliminates *all* machining operations, which previously required 20 hours per 100 pieces.

All the parts which illustrate this page are made by The Presmet Corporation, Worcester, Massachusetts, a custom supplier of high-precision powder metal parts. Like most powder metal parts producers, Presmet relies heavily on Stokes Presses.

STOKES

STOKES MAKES: High Vacuum Equipment, Vacuum Pumps and Gages / Industrial Tabletting, Powder Metal and Plastics Molding Presses / Pharmaceutical Equipment

BLC

Are you one of a select group of aerodynamicists sincerely interested in boundary layer control projects? The Aircraft Division of Fairchild offers a genuine creative opportunity to such men.

Reconnaisance aircraft . . . jet fighters . . . jet bombers and transports . . . as well as engineering advances on the world-renowned C-119 Flying Boxcar and soon-to-be-produced C-123 Assault Transport are coming from Fairchild. Diversified, stimulating assignments like these increase the inventive challenge to Fairchild's team of qualified aerodynamicists.

Gracious country living only minutes away from urban Baltimore or Washington . . . paid pension plan . . . an excellent salary with paid vacations . . . an ideal working environment . . . generous health, hospitalization and life insurance . . . and the many other benefits of a progressive company add to the pleasure of working with Fairchild.

You'll be investing wisely in a secure future if you take time today to write to Walter Tydon, Chief Engineer, outlining your qualifications. Your correspondence will be kept in complete confidence, of course.

☆ **BOUNDARY LAYER CONTROL**

ENGINE AND AIRPLANE CORPORATION
FAIRCHILD
Aircraft Division
HAGERSTOWN, MARYLAND

NEW complete guide to better use of

COMPRESSED AIR POWER

Here's practical technical help on the whole range of compressed - air equipment and systems — how they're planned, selected, tested, operated, and maintained. Every important type of apparatus is covered — pneumatic tools, rock drills, and other air-powered devices, compressors, drivers, piping, and even entire compressed-air distribution systems.

Whether you want answers to questions on operating a jackhammer or are faced with engineering an entire compressed-air system, this book can help you—show you how to reduce labor costs and increase profits with compressed air! It's all from the one best source for this kind of data—the experts who have spent years making and using all types of compressed - air equipment and accessories.

COVERS
- —compressors
- —air-powered drills
- —rotating grinders
- —pneumatic hammers and riveters
- —air hoists
- —*and scores more!*

Just Published—Second Edition!

COMPRESSED AIR HANDBOOK

By the Compressed Air and Gas Institute
Second Edition, 383 pages, 6 x 9
71 tables, 335 illustrations, $8.00

This handbook, simply written yet technically thorough, gives you an enormous fund of information on pneumatic grinders, drills, and impact wrenches, air hoists, drivers, stopers, etc. An entire section devoted to the industrial applications of compressed-air power guides you in selecting the **right** piece of compressed-air equipment for a particular industrial job.

The entire set-up of the compressed-air system is discussed in detail. You get specific information on all types of compressors, drivers, intake air filters, aftercoolers, air receivers, and interconnecting piping—everything you need for top results from compressed air power!

Testing

Gives you each step in testing to determine the performance of air compressors and blowers and to make sure they stand up to performance guarantees. These methods are based on the ASME Power Test Codes for Centrifugal Compressors, Displacement Compressors, Blowers, and Vacuum Pumps.

This Second Edition features a new section on centrifugal compressors and additional data on new types of pneumatic tools, displacement-type compressors, and compressor installation methods.

Low price

Send coupon below and see **Handbook** 10 days free. After 10 days, if satisfied, you pay just $8.00 for this 383-page compressed-air guide. If you don't want book, simply return it and the matter is closed — no obligation.

10 DAYS' FREE EXAMINATION

McGraw-Hill Book Co., Inc., Dept. PE-9
330 West 42nd Street, N. Y. C. 36

Send me **Compressed Air Handbook** for 10 days' examination on approval. In 10 days I will remit $8.00 plus few cents delivery, or return book postpaid. (We pay delivery if you remit with this coupon; same return privilege).

(PRINT)
Name .....
Address .....
City .....Zone...State.....
Company .....
Position .....

This offer applies to U. S. only PE-9

MORE THAN 300 LEADING MANUFACTURERS

are already putting

SKF TYPE "C" BEARINGS

in their products

Here are the trade marks of a few of more than 300 leading manufacturers – companies who want extra bearing performance – who already are using the *improved* SKF Type "C" Spherical Roller Bearing announced less than a year ago.

There are two reasons why

First: They know that for over 40 years, SKF has been *first* with anti-friction developments that *work*.

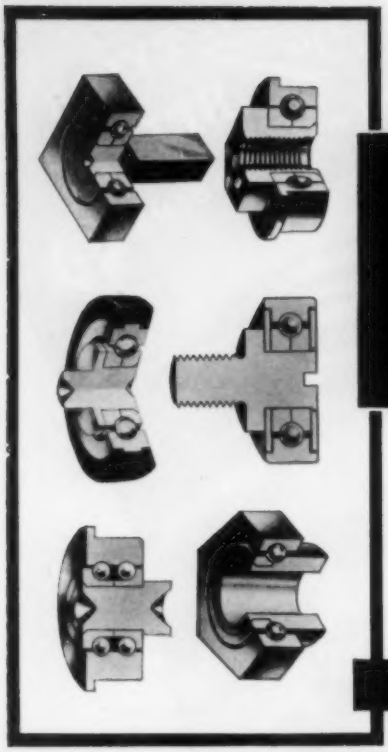
Second: They obtain, size for size, up to 50% more capacity, 2 to 3½ times increased life with SKF's Type "C" Spherical than they can obtain with any other available design, and at no increase in cost.

7550

SKF INDUSTRIES, INC., PHILADELPHIA 32, PA.
– *manufacturers of* **SKF** *and* HESS-BRIGHT® *bearings.*

©1954 – SKF Industries, Inc.

SKF®
BALL AND ROLLER BEARINGS



UNGROUND BALL BEARINGS

For All Industries

KILIAN

Long life and service are assured you because —

1. All component parts are machined from steel bars.
2. Each component part is properly heat treated.
3. Every Kilian Bearing is designed for a specific application.

Neoprene and Nylon tired outer races are available where quiet operation is desired.

Distributors in All Principal Cities ***Catalog on Request***

KILIAN MANUFACTURING CORP.

SYRACUSE, NEW YORK, U. S. A.

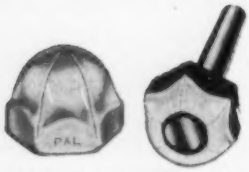
ASSOCIATED COMPANIES: Kilian Manufacturing Corp. (Canada), Ltd. 240 Fleet St. East, Toronto 2B, Ont. · Fischer Bearings (Canada), Ltd. 240 Fleet St. East, Toronto 2B, Ont. · Kilian Steel Ball Corporation 100 Wellington St., Hartford, Conn.

NO THREADS NEEDED!

PUSHNUTS

Trademark

Low cost—speedy assembly—hold tight

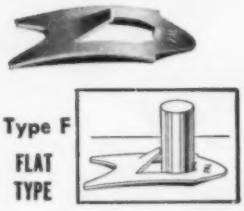


Type C **Type K**

For unthreaded Rods and Axles

Used on wheels of play vehicles; also other permanent applications.

Place PUSHNUT on rod, tap with hammer. Patented locking method resists 100 lbs. or more. Eliminates threading, notching, cotter pins. Made of heat-treated spring steel, in pleasing acorn or semi-acorn styles and various finishes, for 3/16", 1/4" and 5/16" rod.



Type F FLAT TYPE

For unthreaded Studs and Rods

Ideal for nameplates, mouldings and other light parts.

Slips easily over stud, instantly locks with push of simple inexpensive applicator. Spring tension pulls parts snugly to base—energized grip holds tight against loosening or rattling. Choice of finishes for 1/2", 1/8" and 3/4" studs.

Write for free samples, stating size and application.

THE PALNUT COMPANY

Manufacturers of PALNUT® Lock Nuts and Fasteners

65 Cordier St., Irvington 11, N. J.

In Canada: P. L. Robertson Mfg. Co., Ltd., Milton, Ont.

DESIGNED AND DEVELOPED BY SPECIALISTS FOR **PRINTED CIRCUIT** OPERATIONS

VULCAN "EVEN-DIP" SOLDER POTS

- 16 Crucible sizes
- High Fidelity thermostat control—adjustable 150-600° F.
- Surface Temperatures do not vary beyond ± 2° F. Localized "hot spots" completely eliminated.
- Replaceable heavy-duty heating elements.

SEND FOR FREE, DETAILED SPECIFICATIONS

VULCAN ELECTRIC COMPANY, DANVERS 18, MASS.

Compare actual O-ring samples

Prove by comparison tests how Parker O-rings seal better and last longer

For trouble-free leakproof sealing, you can depend on Parker O-rings. They are precision molded of superior compounds that have been developed as the result of thousands of tests.

Elongation, tensile strength, compression set ratings, resistance to oils, fuels, chemicals, and high and low temperatures, are determined with care. Then, laboratory and service tests make sure that all rated characteristics are held.

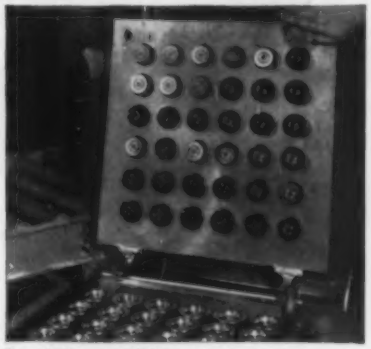
From Parker you can get exactly the *right* O-ring for your *specific* application. We invite you to compare Parker O-rings with any other make. Our engineering service will also help you with designing problems.

Send for complete engineering data today. Mail the coupon for your *free* data book or ask your Parker O-ring distributor for a copy.

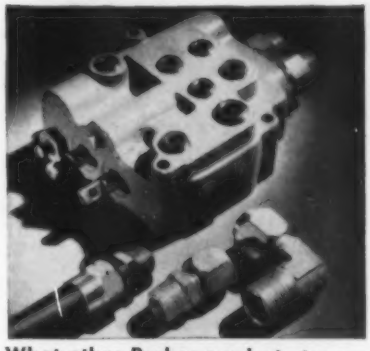
RUBBER PRODUCTS DIVISION
The Parker Appliance Company
17325 Euclid Ave., Cleveland 12, Ohio
1538 So. Eastern Ave., Los Angeles, Cal.

Parker
Hydraulic and fluid system components

Laboratory and service tests check compound resistance to oils, fuels and chemicals at high and low temperatures ... assuring the long life of Parker O-rings.



Precision molding by exclusive, automatically controlled methods assures close-tolerance fits. Parker has molds for every *standard* O-ring size. Send for data.



What other Parker products interest you? *Triple-lok* flare tube fittings? *Ferulok* flareless tube fittings? *Hoze-lok* fittings? New hydraulic directional control valves?

RUBBER PRODUCTS DIV.
Section 511-L
The Parker Appliance Co.
17325 Euclid Avenue
Cleveland 12, Ohio

☐ O-ring Catalog No. 5100
☐ Custom-molded Rubber Cat. No. 5201A1

Name_____ Title_____
Company_____
Address_____
City_____ State_____

YOU NAME IT-

FELT

by FELTERS

will do it...

Filters
Auto parts
Washers
Noise dampeners
Wicks
Packings
Liners
Electrical appliances
Aircraft parts
Shock absorbers
Vibration controls

(Your product goes here)

Resiliency that permits constant spring-back to original shape . . . and good absorptive characteristics . . . are just two of the many properties you can get in Felt made by Felters.

If you have a problem that could be solved by a soft, porous material, or by a hard, dense material — your answer could well be a Felt made by Felters.

The "Felters Design Book" describes several usual and unusual uses for Felt. Drop us a line and we will send you a copy.

HEARD ABOUT **UNISORB®** *— THE MODERN MACHINERY MOUNTING?*

The **FELTERS** Company
228 South Street, Boston 11, Mass.

ON OUR STAFF

If you need effective, highly readable, smartly illustrated company literature (booklets, pamphlets, manuals) to display your products, inform the public of your operations, attract key personnel to your plant, and perform any of the other communicative functions vital to your business, let TECHNICAL WRITING SERVICE do the job for you.

WRITING • EDITING

ILLUSTRATING

PRINTING

We produce your publications, to your specifications. We give complete service—from research and planning through writing, design, and printing. Let our staff be your staff. It will save you time and money.

— We Prepare —

EQUIPMENT MANUALS HANDBOOKS • PRODUCT BULLETINS • TRAINING AIDS PAMPHLETS • REPORTS BROCHURES • COMPANY HISTORIES • PARTS LISTS and other such special material.

Write • Phone
TECHNICAL WRITING SERVICE
McGraw-Hill Book Co., Inc.
330 W. 42nd St., N. Y. 36, N. Y.
LOngacre 4-3000

***finished* part cold-extruded in one piece**

Let Mullins Koldflo produce your ideal designs at *less cost!*

PRECISION steel parts like this can be *mass-produced*—at less cost—by the new Mullins *Koldflo** process. These extrusions are finished—no machining or fabricating required. Now, with fewer manufacturing limitations, you can design cylindrical parts the way you *want* them—without compromise. If you require precision parts, in high volume, call the nearest Mullins office today for engineering appraisal. Write for your copy of the new 16-page bulletin, *"How Would You Tool-up to Make an Egg?"*

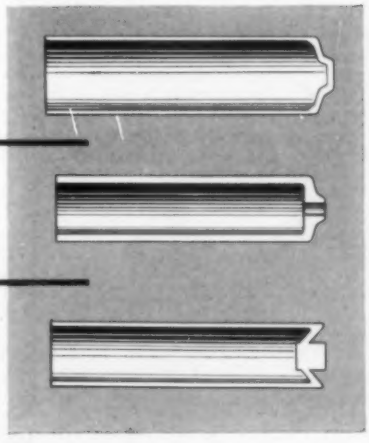
*Trade Mark

Here is what designers say about Koldflo extrusions:

Pump manufacturer says:
"Surface finish and tolerance on our main pump body are critical. Your cylinders meet specifications at lower cost."

Auto manufacturer says:
"Our application involves high pressures. One-piece Koldflo extrusions provide assurance of required strength, at a saving."

Steel products manufacturer says:
"Surface finish, close tolerance and low cost all important. Your design meets our requirements."



DISTRICT SALES ENGINEERING OFFICES

New York
500 Fifth Avenue
Phone: Pennsylvania 6-2773

Detroit
18268 James Couzens Highway
Phone: Diamond 1-1490

Chicago
332 South Michigan Avenue
Phone: Harrison 7-3725

Koldflo
DIVISION
MULLINS MANUFACTURING CORPORATION
Salem, Ohio

Phone — Salem 8771

✓ CHECK THE HANSEN

SYNCHRON®

TIMING MOTOR

—against your specific need for a self-starting synchronous motor

- Is it dependable, trouble-free?
  Users report up to 10 years continuous operation from SYNCHRON Motors without servicing.
- Will it pull up to 8 in. oz. at 1 RPM?
  SYNCHRON is guaranteed to do so.
- May it be stalled continuously without injury?
  The SYNCHRON Timing Motor can be!
- Will it operate in extreme temperatures?
  SYNCHRON is guaranteed to perform satisfactorily from —40° F. to +140° F.
- Will it start instantly under load?
  SYNCHRON will!
- Is it made by a dependable manufacturer?
  The Hansen Mfg. Co., makers of SYNCHRON Timing Motors, have been producing synchronous motors since 1927.
- Is engineering help available?
  Designers are invited to submit their problems to SYNCHRON engineers for study and advice, without obligation.

Your product is no better than the motor which powers it. Use the "Work Horse of the Industry" SYNCHRON

NOTE TO DESIGNERS

Write for complete engineering data showing how easily SYNCHRON Timing Motors, Timing Machines and Clock Motors may be applied to mechanisms now in production or still in the planning stage. Consult HANSEN engineers without obligation.

HANSEN MANUFACTURING CO., Inc., PRINCETON, IND.

HANSEN MANUFACTURING CO., INC., Princeton 5, Ind.
Send catalog and engineering data to:

Name .....
Firm .....
Address .....
City ..... Zone ..... State .....

Now in its 6th year

NOPAK Shelf-Stock Service...

based on these 2 Standard Mounting, Class 1, Cushioned Cylinders

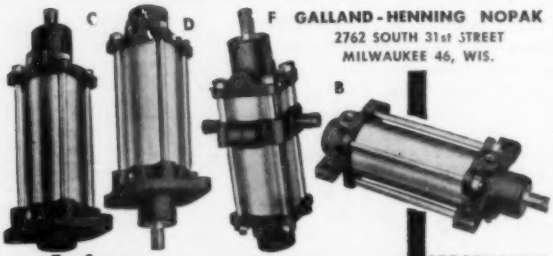
LIST PRICES F.O.B. Milwaukee, Wisconsin — Subject to Revision.

Cyl. Dia. Bore ↓	STOCK STROKE LENGTHS — All Double Acting								
	1"	2"	3"	4"	6"	8"	10"	12"	15"
1½"	24.16	25.72	26.08	26.44	27.16	27.88	28.60	29.32	30.40
2"	26.24	27.88	28.32	28.76	29.64	30.52	31.40	32.28	33.60
2½"	32.36	34.12	34.68	35.24	36.36	37.48	38.60	39.72	41.40
3"	35.04	37.28	37.92	38.56	39.84	41.12	42.40	43.68	45.60
4"	40.84	43.68	44.52	45.36	47.04	48.72	50.40	52.08	54.60
4½"	48.96	51.92	52.88	53.84	55.76	57.68	59.60	61.52	64.40
6"	66.60	70.80	72.20	73.60	76.40	79.20	82.00	84.80	89.00
8"	.....	126.80	129.20	131.60	136.40	141.20	146.00	150.80	158.00

By specifying NOPAK Shelf-stock, you buy *quality* cylinders at lowest prevailing prices, you *eliminate waiting* for "specials", reduce engineering costs. Compare the prices and scope of NOPAK Shelf-stock (1½ x 1" to 8 x 15") with competitive offerings — and you *will specify* NOPAK.

● Basic mountings "A" or "E" convertible to "B", "C", "D" or "F", (see below) by changing cylinder heads. Add 10% to above prices (no extra charge 8" bore). ● Piston Rods NF male thread. ● Cushioning can be eliminated on rod, blank or both ends by removing spring and ball-check.

NOPAK 4-Way Valves, hand, foot, solenoid, or pilot operated, to actuate all cylinders, *also in Shelf-stock*.



GALLAND-HENNING NOPAK
2762 SOUTH 31st STREET
MILWAUKEE 46, WIS.

NOPAK

VALVES AND CYLINDERS
DESIGNED for AIR and HYDRAULIC SERVICE

TEAR OUT THIS AD for Reference — or write for extra copies.

A 8003-½-R

Tough, lightweight Plastic expands into shape

A handful of Koppers Expandable Polystyrene will foam into millions of small bubbles when heated. Pour some grains of this polystyrene into a mold of any shape; apply heat and the plastic will expand to fill the entire cavity. Polystyrene foam creates a tight network of small cells, all fused together to make a strong, tough mass. Products made this way are light, rigid and smooth. Then too—they float.

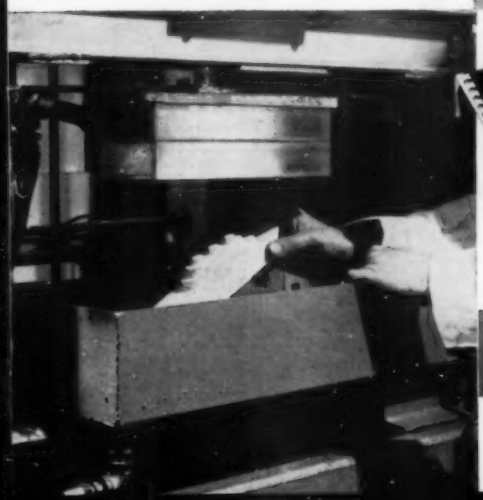
Koppers Expandable Polystyrene makes a fine insulation. The millions of tiny cells trap air and retard heat flow. This plastic *keeps* its insulating value, since it is unaffected by moisture.

Expandable polystyrene has a smooth surface that you can paint.

Koppers Expandable Polystyrene can be used in refrigerators, freezers, life buoys, toys, packages, sandwich building panels and displays. It is the right choice wherever lightweight, strength, insulation, buoyancy, low water absorption, and smooth, precisely molded features are important. Remember, Koppers Expandable Polystyrene is shipped in beads. As a result your freight savings may be as high as 60% of the shipping cost of expanded polystyrene planks and logs.

For more information about Koppers Expandable Polystyrene write for our 26 page booklet today.

Molding is easy. A simple machine is all that is needed to expand this new polystyrene into sheets, blocks, or intricate shapes. The molding operation takes but a few minutes.



Making a mountain out of a molehill. This small pile of polystyrene granules has been foamed up to about 30 times its original size. It can be molded into any shape you need.

KOPPERS COMPANY, INC.
Chemical Division
Dept.PE-94, Pittsburgh 19, Pennsylvania

SALES OFFICES: NEW YORK • BOSTON • PHILADELPHIA
ATLANTA • CHICAGO • DETROIT • LOS ANGELES

Koppers Plastics Make Many Products Better and Many Better Products Possible

KOPPERS®

Koppers Plastics

CLASSIFIED SEARCHLIGHT SECTION ADVERTISING

EMPLOYMENT • BUSINESS • OPPORTUNITIES • EQUIPMENT—USED or RESALE

UNDISPLAYED RATE

$1.50 per line, minimum 3 lines. To figure advance payment, count 5 average words as a line.

(See ¶ on Box Numbers.)

POSITION WANTED undisplayed advertising rate is one-half of above rate, payable in advance.

PROPOSALS $1.50 a line an insertion.

INFORMATION

BOX NUMBERS care publication count as 1 line additional in undisplayed advertisements. DISCOUNT of 10% if full payment is made in advance for four consecutive insertions of undisplayed ads (not including proposals.)

EQUIPMENT WANTED OR FOR SALE Advertisements acceptable only in Displayed Style.

DISPLAYED RATES

The advertising rate is $15.10 per inch for all advertising appearing on other than a contract basis. Contract rates quoted on request.

AN ADVERTISING INCH is measured ⅞ inch vertically on one column, 3 columns—30 inches —to a page. P.E.

Send New ADVERTISEMENTS to New York Office, 330 W. 42nd St., New York 36, N. Y., for the October issue closing September 20th

ELECTRONIC ENGRS & PHYSICISTS

You can be SURE . . .

of a lifetime oppty.

If it's

WESTINGHOUSE

Our Expanding Tube Division Offers Good Opportunity for Professional Progress, and a Pleasant Life, amid New York State's Resort Lake-Land ! !

TUBE DESIGNERS:

Any of these fields: Micro-wave tubes, receiving tubes, solid-state devices, image orthicon, traveling wave tubes.

APPLICATION ENGRS:

Circuit exp in one of these fields helpful: Radio, TV, VHF, semi-conductors, sweep circuits.

PRODUCTION ENGRS:

1. For black-&-white and color TV manufacturing. Knowledge photo-sensitized screens, silk screens or printed screens desirable.
2. For power-tube operations, including magnetrons, micro-waves, and semi-conductors.
3. For Quality Control. Elec'l Engineering background desirable.

Interview expenses paid. Send resume:

Westinghouse Elec. Corp. P. O. Box 284 Elmira, N. Y.

Standard Register Co.

A variety of Engineering and Technical opportunities are available for recent graduates as well as experienced men in the chemical, physical, mechanical and design areas. Because of the nature of our organizational make-up, the positions are varied and interesting. The best in employee benefits is offered, including insurance and retirement.

Send brief resume to Employment Manager

THE STANDARD REGISTER CO
Dayton 1, Ohio

REPLIES (Box No.): Address to office nearest you
NEW YORK: 330 W. 42nd St. (36)
CHICAGO: 520 N. Michigan Ave. (11)
SAN FRANCISCO: 68 Post St. (4)

POSITIONS WANTED

MACHINE DESIGNER — Mining and Automatic production machinery experience, age 48. Will relocate, resume on request. PW-3048, Product Engineering.

REINFORCED PLASTICS Engineering Executive. Thoroughly familiar with all techniques and phases of manufacturing small and very large objects. Excellent stress analyst and machine designer. Experienced in cost estimates, control, and administrative supervision. Energetic, inventive, with proven record of accomplishments. Presently employed with nationally known manufacturing company. Earnings $10,000 plus bonus. Seeks top-level executive position or opportunity to create or expand reinforced plastics business. PW-3712, Product Engineering.

SELLING OPPORTUNITY WANTED

NEW ENGLAND Firm, established 20 years, presently marketing aircraft quality products to industry, desires additional lines. Write to RA-3706, Product Engineering.

SPECIAL SERVICE

A Representative at large having twenty-seven years Engineering background with connections in the Mechanical, Plastics, Chemical Metallurgical, Textile and Electronics fields in the New England area, announces a service available to you as Liaison, Expediter, Production Placement, Contract Negotiator, Field Service installations, Military or Civilian establishment, Retainer-Contract. Write SS-3773, Product Engineering.

WANTED

ANYTHING within reason that is wanted in the field served by Product Engineering, can be quickly located through bringing it to the attention of thousands of men whose interest is assured because this is the business paper they read.

WANTED NEW PRODUCTS

Los Angeles firm with national aircraft hardware market wants additional proprietary products for mfr. & sale by license or purchase. Will consider purchase of going business. Write

BO-3561, Product Engineering
1111 Wilshire Blvd., Los Angeles 17, Calif.

CONTRACT WORK

Eliminate pin hole porosity troubles with NON-GRAN

Spun CENTRIFUGAL CASTINGS

help make products more dependable — more saleable. For details, write!

AMERICAN NON-GRAN BRONZE CO.
Berwyn, Penna.
Precision Machine Work
Castings — Sand and Centrifugal

CUSTOM MADE
PRECISION

STAMPINGS

IN SMALL LOTS

The tool cost is low . . . actually as low as 15% to 20% of the cost of permanent tools. We guarantee dependable service and delivery on date specified.

• SEND us a sample of blueprint. We'll quote you a price. Or write for detailed information.

DAYTON ROGERS
Manufacturing Company
Minneapolis 7H, Minnesota

We Want to Acquire by Purchase or License
A NEW LINE OF MACHINE TOOLS

Our client—a large, long established manufacturer of high precision machinery—wants a new and distinctive product line. We shall be interested in:

1. A small or medium size machine tool, such as a jig borer, surface grinder, contour grinder, broaching machine, gear generator, etc.
2. An accessory or attachment for machine tools.

The machine, accessory or attachment must be developed to the point of commercial use. Our client is prepared to supply working capital and production facilities needed for rapid development of the business.

Please write, referring to advertisement #84. No commission to us. We are compensated by our client.

WELLING & WOODWARD, INC.
CONSULTANTS IN DIVERSIFICATION AND NEW PRODUCTS
52 VANDERBILT AVENUE NEW YORK 17, N. Y.

10 to 12 ft lengths
ALL METALS
Also Screw Machine Products to Order

EASTERN
Machine Screw Corp.
12-32 Barclay St.
New Haven, Conn.
Makers of H & G Die Heads

(Additional Position Vacant Advertising on opposite page)

PROFESSIONAL SERVICES

GREEN AND SIMES

CONSULTING ENGINEERS

Product Engineering Specialists

Hotel Mariemont Building Cincinnati 27, Ohio

GEORGE H. KENDALL

Consulting Mechanical Engineers

Methods Studies: Process or Product
Redesign Existing Products for Greater Profit, Trouble Shooting Production, Design, Cost Problems, Specialist Automatic Machinery, Process, Controls, New Developments, Patent Studies, Investigations, New Products & Process Engineering Studies
P. O. Box 3 (Est. 1923) Tel. Darien 5-1504
Noroton Heights 3 Offices Darien, Connecticut

WILLARD F. MASON

Consulting Electrical Engineer

Precision Electromechanical Designs
Specialist Slip Ring Assemblies—All Applications
Engineering Administration, Cost Systems
Product Development Programs
Manufacturing Facilities

180 Post Road, Darien, Conn. Darien 5-9039

NEW YORK TESTING LABORATORIES, INC.

CHEMICAL, MECHANICAL, ELECTRICAL METALLURGICAL ENGINEERS

ANALYTICAL CHEMISTS, PHYSICISTS, X-RAY Analysis, Tests of all Materials and Products, Plant and Field Services in Special Measurements of Stress, Sound, Vibration and other. Consultants in Litigation and Process Engineering and Design
80 Washington St. New York City 6, N. Y.

R. C. OSBORN and ASSOCIATES

Electro-Mechanical Engineers

- Product Development
- Styling
- Cost Reduction

Box 251 — Bloomington, Illinois

The Consulting Engineer

By reason of special training, wide experience and tested ability, coupled with professional integrity, brings to his client detached engineering and economic advice that rises above local limitations and encompasses the availability of all modern developments in the fields where he practices as an expert.

Engineers
Your Move

The men we seek are experts in their specialized fields, capable of filling responsible engineering positions with MELPAR, a leader in research and development. Perhaps one of these men may be you. We invite you to learn about our long-range military and industrial programs.

If you are experienced in one or more of the fields listed below, write us about yourself and let us tell you during a personal interview about our past record of success and how you can successfully fit into our future plans.

- ***Data Handling Equipment (magnetic cores, magnetic recording equipment, digital computing techniques, analogue to digital conversion, shaft digitizers).***
- ***Network Theory***
- ***Flight Simulation (servomechanisms, pulse circuitry, electronic cabling)***
- ***High-Frequency Antennas***
- ***Audio and Video Circuit Designs***
- ***Small Mechanisms Design***
- ***Mechanical Packaging of Electronic Components***

Technical Personnel Representative

melpar, inc.

A Subsidiary of the Westinghouse Air Brake Co.

452 Swann Ave., Dept. PE-9, Alexandria, Virginia
or 11 Galen St., Watertown, Mass.

FORD

DEVELOPMENT ENGINEERS

FOR: **Design Engineering, Practical Research, Investigations of Theories, Functional Analysis**

An interesting challenge for senior design engineers to work directly with top project supervisors helping through the prototype stage new developments in:

- **Automatic Control Instruments**
- **Electronic Navigational Aids**
- **Magnetic Amplifiers**
- **Airborne Armament Systems**
- **Guided Missile Controls**
- **Computing Equipment**

For these jobs we are interested in men with two or more years experience in electro-mechanical work related to the above fields or in men with superior scholastic records in physics; electrical, electronic or mechanical engineering.

YOU'LL LIKE WORKING AT FORD INSTRUMENT

- **Not too large, not too small**
- **Stable but progressive company**
- **N. Y. C. location with all its additional varied opportunities**
- **Above-average fringe benefits**
- **Pension Plan**
- **Nine Paid Holidays**
- **Two Weeks vacation with pay**
- **Tuition assistance for further related studies**

Our policy of permanency of positions and continuity of service does not allow us to employ engineers unless there is a *clear and definite need for them projected years into the future.* And we promote from within.
If you can qualify, we urge you to contact by mail, or if in N. Y. C. phone:

Mr. P. F. McCaffrey, Stillwell 4-9000, Extension 416

FORD INSTRUMENT COMPANY

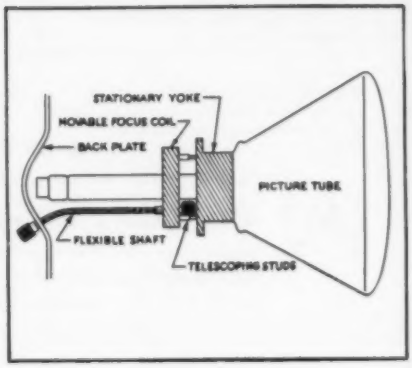
Division of the Sperry Corporation

31-10 Thomson Ave., Long Island City, N. Y. (20 minutes from the heart of New York City)

COST-SAVING IDEAS FOR DESIGN ENGINEERS

S.S.WHITE FLEXIBLE SHAFTS MEET CONTROL PROBLEMS CONVENIENTLY, ECONOMICALLY

Here's a typical example. A standard non-magnetic S.S.White flexible shaft is used to connect the focusing knob mounted on the back plate of a TV to the focusing coil on the tube. The fact that the shaft eliminates alignment problems is a distinct advantage which results in important savings in manufacturing and assembly costs.



SIMPLIFY YOUR CONTROL PROBLEMS

S.S.White remote control flexible shafts are available in a wide range of sizes and characteristics to enable you to meet almost *any* control requirement. You'll find them extremely useful especially where you have to transmit control around turns or where alignment is a problem.

BULLETIN 5306 has basic information and data on flexible shaft application and selection. Send for a free copy. Address Dept. D

R 4

THE S.S.White INDUSTRIAL DIVISION
DENTAL MFG. CO.
10 East 40th Street
NEW YORK 16, N. Y.

Western District Office • Times Building, Long Beach, California

Index of PRODUCTS ADVERTISED

In This Issue

•

A

Accumulators 321

Actuators
Electrical 293
Hydraulic 281, 308
Mechanical 281
Pneumatic 281

Adhesives 48

Air Motors (see Motors, Air)

Aluminum Alloys 2, 34, 66, 297, 441

Aluminum Coated Sheet & Strip (see Steel, Coated)

Anodes 392

Assemblies
Hydraulic 308, 379
Pneumatic 15

Axles 274

B

Bars
Metal 2, 34, 66, 297, 388, 411, 421
Non-Metallic 260

Bearings
Ball 11, 47, 95, 378, 447
Needle 103
Oil-less 277
Roller .....4th Cover, 11, 36, 47, 95, 437 447, 448
Sleeve 11, 277, 388, 421, 439

Bellows 35, 276

Belts 67, 108-109, 247, 341

Bi-Metal 31, 306

Blowers 76, 307

Bolts 86, 365, 392

Books 444, 446

Boosters 321

Brake Motors 263

Brakes
Electric 92, 295, 354
Hydraulic 308
Pneumatic 233

Brass 28-29, 44, 392

Bronze 44, 441

Brushes, Electrical 286

Bushings 11, 286, 388, 421

Bushings, Strain Relief..... 428

Index of

PRODUCTS ADVERTISED

In this issue

•

C

Cameras (see Photographic Equipment)

Cams 250

Carbide Alloys 84-85

Carbon 84-85

Carburetors 420

Castings 96, 265, 310, 329

Castings, Precision Investment..259, 331 360, 413

Catalog Services 322

Chains
- Bead 294
- Roller 11, 45, 57, 254
- Silent 11, 45, 57

Chemical Treatments 8, 274, 311, 330

Clad Metals 31

Clamps, Hose 88

Clutches
- Electrical 92
- Hydraulic 261
- Mechanical 14, 45, 233, 420
- Pneumatic 233

Coatings .....48, 236A&B, 311, 330, 372

Coils 272, 422

Collector Rings 430

Computers 282

Connectors
- Electrical 362
- Hose 379, 380

Contractors 71

Contacts & Contact Materials..... 106 239, 286

Control Panels & Switchboards .....96A, B, C, D

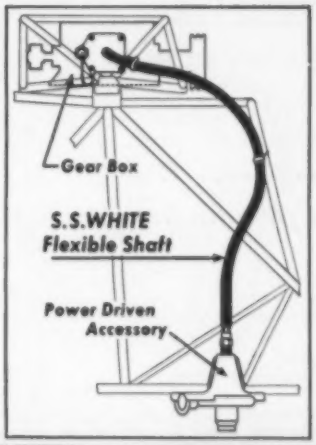
Controls
- Electrical 39, 367
- Hydraulic.....59, 308, 355, 412
- Mechanical 70, 314, 355
- Pneumatic 353, 366

Conveyor Belts 11

COST-SAVING IDEAS FOR DESIGN ENGINEERS

S.S.WHITE FLEXIBLE SHAFTS MAKE EFFECTIVE, LOW-COST DRIVES FOR PARTS AND INSTRUMENTS

The drawing illustrates the point. In this case, an auxiliary pump mounted on the bottom of a helicopter fuselage had to be driven from an accessory gear box. By using an S.S.White flexible shaft to transmit power between the two parts, the drive was accomplished with a minimum of parts and with big savings in installation and assembly time.



FLEXIBLE SHAFTS OFFER MANY ADVANTAGES

They are easy to install, they save parts, are completely dependable in operation, and often make possible simplifications in design which result in improved operation and lower manufacturing costs. It will pay you to investigate their advantages in your own products.

BULLETIN 5306 gives details on how to select and apply flexible shafts. Send for your copy. Address Dept. D

P-4

THE S.S.White INDUSTRIAL DIVISION
DENTAL MFG. CO.
10 East 40th Street
NEW YORK 16, N. Y.

Western District Office • Times Building, Long Beach, California

INDEX OF PRODUCTS

Copper & Copper Alloys.....2, 44, 392

Cords 262

Cork Compositions 264

Counters 17, 440

Couplings (see Connectors, Electrical)

Couplings
- Electrical 92
- Hose 379
- Mechanical 6, 11, 45, 400, 402
- Tube 355

Cylinders
- Hydraulic ...279, 288, 292, 308, 321, 355 366, 374, 452
- Pneumatic..279, 288, 292, 321, 355, 366 374, 383, 452

D

Deep Drawing 451

Die Castings.....49, 58, 63, 80-81 268A, B, C, D, 408

Drafting
- Machines 352
- Supplies 422

Drives
- Adjustable Speed .....26-27 96A, B, C, D
- Hydraulic 261
- Variable Speed.....11, 45, 92, 302, 317 327, 423

Dynamotors 346

E

Electrical & Electronic Components, Custom Made (see also Production Services) 291

Electrochemical Finishes & Treatments 274

Electronic Tubes 346

Engine Indicators & Controls..... 442

Engineering Services (see also Production Services).....64, 236, 243 442, 451

Engines 94, 364, 385, 391, 393, 428

Expanded Metals 435

Extrusions
- Metallic 2, 77, 451
- Non-Metallic 299

F

Fabricated Plastics (see Plastics, Fabricated)

Fabricated Steel (see Structural Shapes; Weldments)

Fabrics 433

Fastening Methods 416-417

Felt 368, 450

Fibre 72-73

Fibre Glass 429

Filters
- Air 15, 270, 365, 373, 400
- Hydraulic 270, 373, 400
- Noise 4

Flexible Couplings..11, 45, 70, 275, 286 381, 402, 424

Flexible Shafts 358, 456-457

Floats 336

Flow Regulators 59, 282, 443

Forgings 2, 66, 98, 284, 375

Friction Materials 33, 108-109

Furniture, Engineering Dept. 422

G

Gages 428B

Gaskets 60, 102, 108-109

Gear Motors (see also Motor Reducers) 56, 76, 307

Gears....245, 255, 256, 300, 309, 314, 334 342, 344, 396A, 399, 418, 422, 444

Generators
- A-C 76, 263
- D-C 76, 263
- High Frenquency 76

Graphite 84-85

H

Hard Surfacing 283

Heat Exchangers 376

Heating Units 220, 290, 448

Hermetic Seals 303

Hose & Tubing 338, 379, 380

I

Inspection Equipment....87, 253, 372, 444

Instruments
- Electrical 442

Insulation 74-75

Insulators 440

Inverters 346

L

Laminated Metals 239

Laminated Plastics (see Plastics, Laminated)

Lubricants 320

Lubricating Equipment...15, 74, 273, 319

M

Machined Parts 323

Magnesium Alloys 61, 320

Magnets 295

Markers, Wire & Insulation..... 372

Metal Forming 97, 320

Metal Powder 50

Moldings
- Plastics (see Plastic Parts)
- Powdered (see Powdered Metal Parts)
- Rubber (see Rubber Parts)

Motor Reducers (see also Gear Motors) 26-27, 307, 317, 354, 381

Motor Starters .....39, 64A&B, 367, 415

Motors, A-C
- Fractional....20-21, 24-25, 26-27, 43 52-53, 76, 90, 99, 263, 287, 317, 325 337, 351, 357, 361, 389, 405, 409, 423
- Integral..20-21, 43, 52-53, 90, 99, 263 287, 325, 337, 354, 357, 389, 405, 423 428A, 430
- Sub-Fractional 51, 76, 287, 307

Motors, D-C
- Fractional....26-27, 43, 52-53, 76, 263 287, 325, 337, 346, 351, 357, 361, 405 409, 423
- Integral ..43, 52-53, 263, 287, 325, 337 354, 357, 405, 423, 428A, 430
- Sub-Fractional 76, 287, 307

Motors, Hydraulic 372

Mountings 339

N

Name Plates 362

Nickel Alloys 42, 46

Nuts 86, 234-235, 343, 365, 392, 400 428, 448

O

Optical Parts 271

P

Packings 312, 419, 427

Paper 78, 382

ADVERTISED IN THIS ISSUE

Pillow Blocks 249

Pins 384, 392

Pipe 2, 65

Piping 267

Plastic Parts 299, 302, 350, 371, 384

Plastics ..72-73, 89, 104-105, 107, 236A&B 250, 401, 403, 404, 429, 453

Plastics Fabricated 350, 371, 384

Plastics Laminated 75, 404

Plates 2, 37

Plugs 362

Porcelain 377, 440

Powdered Metal Parts.... 50, 55, 272, 445

Power Packs
- Electrical & Electronic 354
- Hydraulic 366

Power Take-offs 420

Production Machines & Processes.... 49 248, 394

Production Services (see also Engineering Services)..64, 97, 320, 323, 386 403, 442

Pumps
- Air 270, 445
- Liquid....18-19, 258, 270, 304, 308, 347 348, 355, 372, 412, 424
- Vacuum 270

R

Recorders 387, 420, 426

Regulators
- Electric 425
- Hydraulic 308, 412
- Pneumatic 15, 74

Relays ...64A&B, 266, 268, 285, 308, 362

Reproduction Equipment 352, 436

Reproduction Supplies 436

Resins 16, 22-23, 89, 104-105, 107

Retaining Rings 13

Revolving Joints 438

Rings & Loops 50

Rivets 69, 340, 392

Rod Ends 32

Rods
- Metallic 2, 44, 398

Rubber Parts ..68, 102, 296, 299, 316, 403

S

Screws 62, 79, 86, 289, 348, 356, 392 431, 440

Screw Thread Inserts 237

Sealants 48

Sealers 48

Seals 256, 273, 300B, 315, 333, 364B 397, 449

Servomechanism Components 328

Shapes, Rolled Formed 414

Sheets
- Metal 2, 37, 300A

Shock Absorbers 281

Specialty Fasteners (Pipe Hangers, Special Cold Headed Parts, etc.)... 93 289, 326, 343, 440

Speed Reducers 255, 396B

Springs 291, 443

Sprockets 11, 45, 57

Stampings 49, 88, 403, 410, 424, 443

Steel
- Alloy 37, 38, 83, 411
- Carbon 38, 411
- Stainless 37, 38, 65, 83, 241 300A, 406
- Tool 37, 83

Strainers 270

Strips, Metallic...2, 38, 44, 100-101, 300A 364A, 398

Structural Forms & Shapes...10, 97, 243

Subcontracting Services 320

Switches ...39, 40-41, 324, 332A&B, 359 384, 415

Swivel Joints 395, 438

T

Tables, Dial-Feed 462

Tapes 264

Tapes, Insulating (see Insulation)

Terminals & Terminal Boards 347

Testing Machines & Equipment..87, 253 313, 372

Thermostats 30, 360

Timers 266, 275, 290, 301, 335

Timing Motors 51, 266, 452

Tools 336, 345

Torque Converters 391

Tracing Cloth 436

Transformers 305

Transmissions 327

Tubing
- Lock-Seam 2, 414
- Seamless 2, 77, 83, 376, 396
- Welder ...2, 37, 65, 77, 91, 267, 269, 349

U

Universal Joints 292, 298

V

Valves
- Air 11, 15, 336, 355, 374, 452
- Hydraulic ..59, 237, 251, 282, 308, 336 355, 374, 412, 444, 452

Vibration Dampers
- Mechanical 339

Vibration Mountings 278, 403

Vibratory Equipment 313

W

Washers 88, 370, 392, 416-417, 421

Washers (see Packings)

Welding
- Equipment 407
- Nuts 332

Weldments 363, 390

Wire 369, 398, 406

Wire & Cable 305, 369

Wire Cloth 54, 280, 318, 392

Wire Forming 443

Z

Zinc 12

INDEX TO

This index is published as a convenience to the readers. Every care is taken

Acme Chain Crop. 254
Acro Switch Div., Acro Mfg. Co..... 324
Acushnet Process Co..... 296
Advance Electric & Relay Co..... 308
Aeroquip Corp. 380
Ahlberg Bearing Co..... 249
Aircraft-Marine Products, Inc..... 345
Ajax Flexible Coupling Co..... 70
Alemite 74
Allegheny Ludlum Steel Corp..... 241
Allen-Bradley Co. .....64A, B
Allied Research Products, Inc..... 311
Allis-Chalmers Mfg. Co.....43, 71
Allmetal Screw Products Co., Inc.... 348
Alloy Metal Wire Div., H. K. Porter Co., Inc. 398
Aluminum Co. of America Screw Machine 34
American Brass Co.....28-29
American Chemical Paint Co..... 330
American Cystoscope Makers, Inc... 372
American Hard Rubber Co..... 299
American Insulator Corp. 371
American Screw Co. 79
American Steel & Wire Div., U. S. Steel Corp...32A, B, C, D, 38, 100-101
Ampco Metal, Inc..... 441
Anker-Holth Div., Wellman Engineering Co. 288
Apex Machine & Tool Co..... 298
Armco Steel Corp..... 212
Armstrong Cork Co.....33, 60, 264
Arrow-Hart & Hegeman Electric Co. 367
Arwood Precision Casting Corp..... 360
Atlantic Casting & Engineering Co... 331
Atlantic Screw Works, Inc..... 79
Austenal Laboratories, Inc..... 259
Automatic Switch Co..... 251
Automotive Gear Works, Inc.....396A
Aviation Developments, Inc..... 384
Avon Tube Div., Higbie Manufacturing Co. 269

Bakelite Co., Union Carbide & Carbon Corp. 16, 89, 107, 111
Baldor Electric Co. 325
Barco Mfg. Co..... 438
Barrett Div., Allied Chemical & Dye Corp. 104-105
Barry Corp. 278
Bausch and Lomb Optical Co..... 271
Bead Chain Mfg. Co., Inc..... 294
Bendix-Red Bank Div., Bendix Aviation Corp. 346
Bendix-Skinner Div., Bendix Aviation Corp. 400
Bethlehem Steel Co..... 10
Bijur Lubricating Corp..... 319
Bishop & Co., J. Platinum Works Stainless Steel Div..... 396
Blake & Johnson Co..... 79
Bond Co., Charles 422
Bound Brook Oilless Bearing Co.... 277
Brainard Steel Div., Sharon Steel Corp. 349
Bridgeport Brass Co..... 44
Bristol Co., Socket Screw Div..... 356
Brook Motor Corp..... 90
Brooks & Perkins, Inc..... 320
Brown Engineering Co..... 400
Bruning Co., Inc., Charles..... 352
Brush Electronics Co..... 87
Bunting Brass & Bronze Co..... 388
By-Products Steel Co., Div. of Lukens Steel Co. 97

Calidyne Co. 313
Cambridge Wire Cloth Co..... 280
Cameron Iron Works, Inc., Forge & Ordnance Div. 375
Camloc Fastener Corp..... 326
Carpenter Steel Co..... 37
Carpenter Steel Co., Alloy Tube Div. 65
Central Screw Co..... 79
Century Electric Co..... 357
Chace Co., W. M..... 306
Chain Belt Co. 57
Chase Brass & Copper Co..... 392
Chemical Corp. 274
Chicago Rawhide Mfg. Co.....2nd Cover
Chicago Thrift-Etching Corp..... 362
Chiksan Co. 395
Chrysler Corp., Industrial Engine Div. 391
Cincinnati Gear Co..... 314
Cincinnati Industries, Inc..... 382

Clare Co., C. P..... 285
Clark Controller Co.....332 A, B
Cleveland Cap Screw Co..... 289
Cleveland Pneumatic Tool Co..... 281
Cleveland Welding Co., subs. Amer. Machine & Foundry Co..... 390
Cleveland Worm & Gear Co..... 255
Clifford Mfg. Co..... 35
Climax Molybdenum Co..... 320
Cold Metal Products Co..... 221
Columbia-Geneva Steel Div., U. S. Steel Corp.....32 A, B, C, D, 100-101
Cone-Drive Gears Div., Michigan Tool Co. 418
Consolidated Engineering Corp..... 426
Consolidated Molded Products Corp. 384
Continental Diamond Fibre Co..... 75
Continental Rubber Works 316
Continental Screw Co.....79, 223
Copper & Brass Research Association ..112-113
Coto-Coil Co., Inc..... 272
Cramer Co., Inc., R. W..... 301
Crane Co. 225
Crane Packing Co. 333
Crucible Steel Co. of America..... 406
Curtis Universal Joint Co., Inc..... 292
Cutler-Hammer, Inc. 415

Daystrom Instrument 442
DeLaval Steam Turbine Co..... 245
Delco Products Div., General Motors Corp. 99
Denison Engineering Co..... 443
Dexter Machine Products, Inc..... 444
Diehl Manufacturing Co., Inc..... 405
Dodge Mfg. Corp.....396B
Doehler-Jarvis Div., National Lead Co. 80-81
Doerr Electric Corp..... 208
Dormeyer Industries 422
Dow Chemical Co..... 61
Dudco Div., The New York Airbrake Co. 18-19
Dudek & Bock Spring Mfg. Co..... 442
Durakool, Inc. 275
Durametallic Corp. 256
Dynamatic Corp., Subs. of Eaton Mfg. Co. 92

Eagle Lock Co..... 79
Eagle Signal Corp..... 335
Eastern Air Devices, Inc..... 76
Eastman Kodak Co., Special Products Sales Div. 253
Eastman Mfg. Co. 379
Eaton Mfg. Co., Dynamatic Corp..... 92
Ebert Electronics Co..... 362
Elastic Stop Nut Corp. of America ..234-235
Elco Tool & Screw Corp..... 79
Electrol, Inc. 308
Electrical Engineering & Mfg. Corp. 293
Electro Dynamics Div., General Dynamics Corp. .....428 A
Emerson Electric Mfg. Co..... 337

Fairbanks, Morse & Co., Electric Motor Div. 52-53
Fairchild Engine & Airplane Corp... 302
Fairfield Mfg. Co..... 300
Falk Corp. 381
Fawick Airflex Div., Federal Fawick Corp. 231
Federal Mogul Corp. 421
Fellows Gear Shaper Co..... 394
Felters Co. 430
Firestone Plastics Co., Chemical Sales Div., Div of Firestone Tire & Rubber Co. 22-23
Flex-O-Tube, Div. of Meridan Corp. 338
Flexonics Bellows Div. 124
Foote Bros. Gear & Machine Corp... 110
Ford Motor Co., Industrial Engine Dept. 385
Fulton Sylphon Div., Robertshaw Fulton Controls Co..... 276

Galland-Henning, Nopak Div..... 452
Garlock Packing Co..... 312
Garrett Co. Inc., George K..... 88
Gear Specialties, Inc..... 399

General American Transportation Corp., Plastic Div..... 227
General Controls Co..... 59
General Dynamics Corp., Electro Dynamics Div. 428A
General Electric Co., Apparatus Sales Div. 116-121
General Tire & Rubber Co., Industrial Products Div. 403
Gerotor May Corp..... 372
Geuder, Paeschke & Frey Co., Contract Div. 410
Gits Bros. Mfg. Co..... 273
Gleason Works 6
Globe Industries, Inc..... 307
Goodrich Co., B. F. (RIVNUT)..... 69
Graphite Metallizing Corp. 286
Graton & Knight Co..... 315
Gray Iron Founders' Society, Inc..... 96
Great Lakes Screw Corp..... 79
Gries Reproducer Corp. 302
Grip Nut Co..... 400
Guardian Products Corp..... 275

Hamilton Watch Co., Allied Products Div. 323
Hanna Engineering Works..... 374
Hannifin Corp. 366
Hansen Mfg. Co., Inc..... 452
Harper Co., H. M..... 79
Hart Mfg. Co..... 268
Harvey Aluminum Sales, Inc..... 66
Haydon Co., A. W..... 290
Haydon Mfg. Co., Inc..... 266
Haynes Stellite Co., Div. of Union Carbide & Carbon Corp..... 413
Heim Co. 32
Heli-Coil Corp. 257
Heyman Mfg. Co..... 428
Hilliard Corp. 402
Hommel Co., O..... 372
Honan-Crane Corp. 373
Hoover Co., Electric Motor Div.....20-21
Houghton & Co., E. F..... 419
Howell Electric Motors Co..... 389
Hyatt Bearings Div., General Motors Corp. 36
Hydreco Div., The New York Airbrake Co. 18-19

I-T-E Circuit Breaker Co., Special Products Div. 236
Instrument Specialties Co., Inc..... 291
International Nickel Co., Inc.....42, 46
International Packings Corp..... 315

Jack & Heintz, Inc.....24-25
Johns-Manville Corp. (Packings)....300B
Johnson Bronze Co..... 439
Johnson Machine Co., Carlyle..... 14

Kaiser Aluminum & Chemical Corp. 297
Kaydon Engineering Corp..... 95
Kellogg Co., M. W., Chemical Mfg. Div. .....236 A & B
Keystone Carbon Co..... 272
Kilian Mfg. Corp..... 448
Koppers Co., Inc., Chemical Div..401, 433
Koven & Bro., Inc., L. O..... 386
Kralssl Co. 270

Ladish Co., Tri-Clover Div..... 267
Lamb Electric Co..... 351
Lamson & Sessions Co.....79, 86
LaSalle Steel Co..... 411
Lebanon Steel Foundry..... 329
Lefax 444
Librascope Inc..... 282
Lincoln Electric Co..... 252
Linde Air Products Co., Div. of Union Carbide & Carbon Corp..... 283
Linear, Inc. 427
Link Belt Co.....11, 47
Logansport Machine Co., Inc..... 355
Lord Mfg. Co..... 339
Lovejoy Flexible Coupling Co..... 424

ADVERTISERS

to make it accurate but PRODUCT ENGINEERING assumes no responsibility for errors or omissions.

Lukens Steel Co., By-Products Steel Co. 97
Lundey Associates 303
Lycoming Divisions, Avco Mfg. Corp. 364

McCauley Metal Products, Inc..... 424
McGill Mfg. Co., Inc..... 229
McGraw-Hill Book Co., Inc..... 446
McLouth Steel Corp.....300A
Madison-Kipp Corp. 408
Mahon Co., R. C..... 363
Makepeace Co., D. E..... 239
Malleable Founders' Society..... 310
Mallory & Co., Inc., P. R.....4, 106
Manheim Mfg. & Belting Co..... 67
Massachusetts Gear & Tool Co..... 256
Master Electric Co. (Speedmaster) 3rd Cover
Mayline Co. 422
Mead Specialties Co..... 383
Metals & Controls Corp., General Plate Div. 31
Metals & Controls Corp., Spencer Thermostat Div. 30
Michigan Tool Co., Cone Drive Gears Div. 418
Micro Switch Div., Minneapolis-Honeywell Regulator Co.....40-41
Midland Steel Products Co..... 332
Miller Fluid Power Co..... 321
Minnesota Mining & Mfg. Co..... 48
Minnesota Rubber & Gasket Co.....364 B
Monsanto Chemical Co., Plastics Div. 210
Moraine Products Div., ... General Motors Corp..... 55
Morse Chain Co..... 45
Mosinee Paper Mills Co..... 78
Mt. Vernon Die Casting Corp..... 58
Mueller Brass Co..... 284
Mullins Mfg. Corp., Koldfio Div..... 451
Murphy Frank W..... 442

National Acme Co..... 359
National Band & Tag Co..... 372
National Lead Co..... 49
National Lock Co..... 79
National Lock Washer Co..... 370
National Malleable & Steel Casting Co. 265
National Pneumatic Co., Inc..... 409
National Screw & Mfg. Co..... 79
National Standard Co..... 369
National Tube Div.....32A, B, C, D
National Vulcanized Fibre Co.....72-73
Newark Wire Cloth Co.....318
New Departure Div., General Motors Corp. 128
New Jersey Zinc Co..... 12
New York Air Brake Co.....18-19
New York Belting & Packing Co. (Gilmer Timing Belt Div.)....247, 341
Nicholson & Co., W. H..... 336
Norgren Co., C. A.....15, 214

Ohio Gear Co..... 334
Ohio Seamless Tube Div. of Copperweld Steel Co..... 219
O'Neil Irwin Mfg. Co..... 248
Ortman-Miller Machine Co..... 292

Packard Electric Div., General Motors Corp. 361
Palnut Co. 448
Parker Appliance Co., Rubber Products Div. 449
Parker-Kalon Div., General American Transportation Co. 79
Parker Rust Proof Co..... 8
Parker Stamp Works, Inc..... 250
Peerless Photo Products, Inc..... 436
Penn Metal Co., Inc..... 435
Perkins Machine & Gear Co..... 344
Pheoll Mfg. Co..... 79
Philadelphia Gear Works, Inc..... 122
Pioneer Pump Div. of Detroit Harvester Co. 304
Pittsburgh Gear Co..... 309
Pittsburgh Plate Glass Co., Fiber Glass Div. 429
Platecoil Div. of Tranter Mfg. Inc... 376
Pneu-Trol Devices, Inc..... 384
Polymer Corp. of Pennsylvania..... 260
Porcelain Enamel Institute, Inc..... 377
Precision Rubber Products Corp..... 397
Process Gear Co., Inc..... 342
Product Engineering 114-115
Production Instrument Co..... 440
Progressive Mfg. Co..... 440

Racine Hydraulics & Machinery, Inc. 412
Raybestos-Manhattan, Inc.....108-109
Equipment Sales Div.
Manhattan Rubber Div.
Packings Div.
Reeves Pulley Co..... 327
Reliance Electric & Engineering Co. 26-27
Republic Manufacturing Co..... 444
Republic Steel Corp., Bolt & Nut Div. 365
Reuland Electric Co..... 354
Revere Copper & Brass Inc..... 2
Reynolds Metals Co., Aluminum Div. 243
Reynolds Wire Div., National-Standard Co. 54
Richardson Co. 404
Robertshaw-Fulton Controls Co., Robertshaw Thermostat Div..... 360
Rochester Products Div., General Motors 91
Rockford Clutch Div., Borg-Warner Corp. 420
Rockford Screw Products Co..... 79
Rockwood Sprinkler Co. (Ball Valve Div.)..... 237
Roll Formed Products Co..... 414
Rollway Bearing Co., Inc..... 437
Roper Corp., Geo. D..... 258
Ross Operating Valve Co..... 1
Russell, Burdsall & Ward Bolt & Nut Co. 431
Rubatex Div., Great American Industries, Inc. 102
Ruthman Machinery Co..... 424

SKF Industries, Inc..... 447
Sanborn Co. 387
Schrader's Son, A., Div. of Scovill Mfg. Co., Inc..... 353
Sciaky Brothers, Inc..... 407
Scintilla Div., Bendix Aviation Corp., Electrical Conn. 362
Scovill Mfg. Co. 79
Screw Research Association..... 79
Servo-Mechanism, Inc. 328
Shakeproof Div. of Illinois Tool Works 416-417
Shakeproof, Inc. 79
Simmonds Aerocessories, Inc..... 314
Simmons Fastener Corp..... 93
Solar Aircraft Co..... 94
Southington Hdwe. Mfg. Co..... 79
Square D Co..... 39
Standard Pressed Steel Co..... 62
Star-Kimble Motor Div., Miehle Printing Press & Mfg. Co..... 263
Stearns Magnetic, Inc..... 295
Stephans-Adamson Mfg. Co., Sealmaster Bearings Div..... 378
Sterling Bolt Co..... 70
Sterling Electric Motors Inc..... 317
Stevens Walden, Inc. 336
Stewart Warner Corp. (Alemite)..... 74
Stewart Warner Corp. (Die Casting Div.) 63
Stokes Machine Co., F. J..... 445
Stow Mfg. Co..... 358
Streeter-Amet Co. 420
Superior Electric Co..... 425
Superior Steel Corp.....364A
Sweet's Catalog Service..... 322

Telechron Dept., General Electric Co. 51
Tennessee Coal & Iron Div. U. S. Steel Corp. 100-101
Thompson-Bremer & Co., Sub. of American Machine & Foundry Co. 343
Thomas Flexible Coupling Co..... 286
Timken Roller Bearing Co. (Industrial) .....4th Cover
Timken Roller Bearing Co., Steel & Tubes Div. 83
Tinnerman Products, Inc..... 126
Tomkins-Johnson Co. 279
Torrington Co. (Needle Bearing)... 103
Torrington Co. (Specialty)..... 64
Tri-Clover Div., Ladish Co..... 267
Tubular Rivet & Stud Co..... 340
Twin Disc Clutch Co..... 261

Union Carbide & Carbon Corp. Bakelite Co. 16, 89, 107, 111
Haynes Stellite Co..... 413
Linde Air Products Co..... 283
United Electric Controls Co..... 432
United Mfg. Co..... 274
U. S. Electrical Motors, Inc..... 423
U. S. Gasket Co. 350
U. S. Gauge Div., American Machine & Metals, Inc.....428B
U. S. Graphite Co. 50, 84-85
U. S. Rubber Co. (Mechanical Goods Div.) 68
U. S. Steel Corp. .....32A, B, C, D
U. S. Steel Export Co. 32A, B, C, D, 100-101
U. S. Steel Supply Co.....32A, B, C, D
Universal Clay Products Co..... 440

V & O Press Co. Div., Emhart Mfg. Co. 462
Veeder-Root, Inc. 17
Vickers, Inc. 82
Viking Pump Co. 348
Vulcan Electric Co..... 448
Vulcan Rubber Pdts., Inc., sub. of Reeves Brothers, Inc..... 433

Wagner Electric Corp..... 287
Waldes-Kohinoor, Inc..... 13
Wales-Beech Corp. 79
Waterman Engineering Co..... 282
Watlow Electric Mfg. Co..... 290
Webster Electric Co., Oil Hydraulics Div. 347
Welco Motors 430
Wellman Engineering Co., Anker-Holth Div. 288
Weache Electric Co., B. A..... 430
Western Felt Works..... 368
Westfield Metal Products Co., Inc.... 428
Westinghouse Electric Corp. 56, 96A, B, C, D
Wheeler Insulated Wire Co., Inc..... 305
White Dental Mfg. Co., S. S.....456-457
Whitney Blake Co..... 262
Wichita Falls Foundry & Machine Co., Inc. 233
Wiegand Co., Edwin L., Ind. Div.... 270
Willys Motors, Inc., Industrial Engine Sales Dept. 393
Wisconsin Motor Corp..... 428
Wolverine Tube Div., Calumet & Hecla, Inc. 77
Wyman-Gordon Co. 96

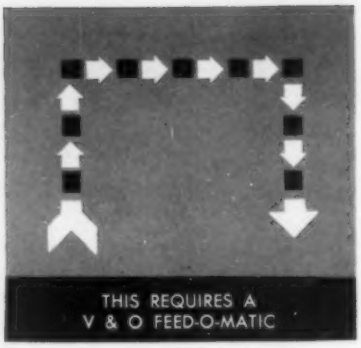
Zenith Carburetor Div., Bendix Aviation Corp. 420

■

PROFESSIONAL SERVICES 454, 455

SEARCHLIGHT SECTION
(Classified Advertising)
H. E. Hilty, Mgr.

EMPLOYMENT
Positions Vacant 454, 455
Positions Wanted 454
Selling Opportunities Wanted..... 454
SPECIAL SERVICES
Contract Work 454
BUSINESS OPPORTUNITIES
Offered 454



THREE PLANE PRECISION POSITIONING IS PRACTICAL

It is entirely practical for a mechanical device to pick up a small part, lift it over or past an obstacle, and place that part with complete precision. V & O Feed-O-Matics are doing this every day.

The small part can travel through three or more planes, through dangerous zones or past dangerous objects, and be placed with complete precision.

Feed-O-Matics eliminate production-slowing devices which are necessary for manual positioning of the parts. They trip devices which human beings never could be trusted to trip. Feed-O-Matic positioning is so highly precise that high cost intricate, fragile tools can be used where with manual feeding no one would dare to use them. Precision of production also is increased.

Feed-O-Matics can work with a minimum of operator attention. They can solve problems for hundreds of types of operations.

Write to us for full details. The V & O Feed-O-Matic has an engineering story that will interest you.

WHY THE V & O LONG SLIDE PROVIDES BETTER ALIGNMENT

With the same running clearance, the longer the slide the less the possibility for angular misalignment. And we keep our running clearances very close indeed.

THE V & O PRESS COMPANY

DIVISION OF EMHART MFG. CO.

HUDSON, NEW YORK

BUILDERS OF PRECISION POWER PRESSES AND FEEDS SINCE 1889

65th Anniversary

Battery of Feed-O-Matics in one user's plant.

T-shaped part being formed in secondary operation.

Feeding two pieces with each stroke of the press.

NEW 3-POINT EASY-TO-USE READER SERVICE TO HELP YOU

. . . find out more about the New Materials and Components described

. . . obtain copies of new catalogs and bulletins

. . . get more information about products advertised in this issue

Now, one of these handy prepaid postcards will bring you more information about any product advertised or mentioned editorially in this issue of *Product Engineering*.

Here's How to Use the Card

For your copy of any new catalog or bulletin, circle key number in the space indicated. Bulletins are described on pages 305 to 320.

To get more data about new Components, Materials and Parts fully described on pages 216 to 304, just circle the appropriate key number.

To get more information about advertised products, circle the page number of the advertisement in which you are interested. If more than one advertisement is located on a single page, letters preceding number identify each advertisement. Key: T – Top; B – Bottom; R – Right; L – Left; TL – Top left; BL – Bottom left; TR – Top right; BR – Bottom right.

For specialized data . . . price, sizes available, nearest source of supply, etc. . . . do not circle key number but indicate your needs in the space alloted at the bottom of the card. Use this space, too, if information about a specific product among several mentioned in an advertisement is desired.

PRINT or TYPE your address before mailing

FIRST CLASS
PERMIT No. 64
(Sec. 34.9 P.L.&R.)
NEW YORK, N. Y.

BUSINESS REPLY CARD
NO POSTAGE STAMP NECESSARY IF MAILED IN THE UNITED STATES

—4¢ POSTAGE WILL BE PAID BY—

PRODUCT ENGINEERING
READER SERVICE DEPARTMENT
330 WEST 42nd ST.
NEW YORK 36, N. Y.

PLEASE TYPE OR PRINT

Name _____

Position _____

Company _____

Address _____

City & State _____ 9-54

NEW PRODUCTS . . . Descriptions of these new engineering materials appear on pages 216 to 304. Circle key number for more data.

1—Set-Screw Electrical Connector
2—Stepless Fhp Motor Control
3—Torque in One Direction Only
4—Hydraulic Cylinders for Air, Oil
5—Easy-to-Replace Pilot Lights
6—Valve "Senses" Malfunctioning
7—Hydraulic Directional Valves
8—Servo Components ¾ in. Dia
9—Rubber Drive Handles Misalignment
10—Interlocking Pushbutton Switches
11—Wax Actuates Thermostat
12—Voltage-Regulated Time Limiting
13—Brakemotor Takes Less Space
14—High-Speed Precision Switch
15—Sealed, Ruggedized Panel Meters
16—Four-Cylinder Industrial Engine
17—Miniature Clutches, Brakes
18—Aluminum-Coated Steel Wire
19—Wire of Unusual Cross-Section
20—Valve Parts Replaced In Service
21—Flag-Type, Right-Angle Terminals
22—Magnetic Fluid Transmission
23—Engine And Generating Plant
24—Insert Locks Screws In Place
25—Motor and Generation Share Housing
26—Coded Wire Meets Specifications
27—Bellows with Standard Flanges
28—Fluctuating-Pressure Transducer
29—Transparent Resin for 350 F
30—Plastic Shaft Retention Ring
31—Crease-Resistant Silicone Coating
32—Spindles and Slides
33—Etched Metal-Enamel Nameplate
34—Oval and Flat-oval Capacitors
35—Drafting Tape
36—Connector Cables
37—Light-Stable Polysterene
38—Gas Flow Control and Measurement
39—Polyethylene Rods Over 7 ft long
40—Hose Designed for Hot Acids
41—Servo Components
42—Vertical Strain Gage Balancer
43—Conveyor Belt Idler
44—Registers Footage Up to 2400 Ft
45—Transmission and Differential
46—Foot Switch for Electronic Units
47—Relay for Tight Quarters
48—Compound Planetary Transmission
49—Expansion Joint With Wedge Seal
50—Flow Regulator
51—Hydraulic Transmission
52—Noiseless Pneumatic Vibrators
53—Miniature Repeat Cycle Timer
54—Valve With Sliding Spool
55—Washer's Pressure Locks Nut
56—Wing Nut Has Serrated Base
57—Molding Compound for Outdoors
58—Two-Switch Governor
59—Impulse Generator
60—High-Torque Rotary Actuator
61—Magnetic Servo Amplifier
62—Flexible Shaft Coupling
63—Rack-And-Panel Connectors
64—Electronic Symbols Template
65—Reversing Drum Switch
66—Variable Auto-Transformer
67—Holding Coil Switch
68—Bearing Hanger With Fast Reverse
69—Gasoline Engine of 2½ Hp
70—40 v Selenium Rectifier
71—Digitizer for Automation
72—Tabletop Reproduction Machine
73—Shafts and Shaft Assemblies
74—Berrylium Copper Strip
75—Holds Leads of All Diameters
76—Metalized Polyester Film
77—Flare Connector For Tubing
78—Joining Alloys for Aluminum
79—Electrical Wiring Components
80—Power Supply
81—Continuous Shiteprinting
82—Heavy Duty Pressure Switch
83—Constant-Speed Motor
84—Simplified Aluminum Enameling

PRINT or TYPE your address on other side before mailing

C2			1	2	4	6	8	10	12	13	14	15	16	17
18-9	20-1	22-3	24-5	26-7	28-9	30-1	31	32a	32b	32c	32d	33	34	35
38	37	38	39	40-1	42	43	44	45	46	47	48	49	50	51
52-3	54	55	56	57	58	59	60	61	62	63	64	64a	64b	65
66	67	68	69	70	71	72-3	74	75	76	77	78	79	80-1	82
83	84-5	86	87	88	89	90	91	92	93	94	95	96	96a	96b
96c	96d	97	98	99	100-1	102	103	104-5	106	107	108-9	110	111	112-3
	116-7	118-9	120-1	122	124	126	128	208	210	212	214	221	223	225
227	229	231	233	234-5	236	236a	236b	237	239	243	245	247	248	249
250	251		252	254	255	TL256	BL256	257	258	259	260	261	262	263
264	265	266	267	268	268a	268b	268c	268d	269	L270	R270	271	TL272	BL272
273	L274	R274	TR275	BR275	276	277	278	279	280	281	TL282	BL282	283	284
285	L286	R286	287	288	289	TL290	BL290	291	L292	R292	298	304	305	306
297	298	299	300	300a	300b	301	TL302	BL302	303	L304	R304	305	306	307
L308	R308	309	310	311	312	313	TL314	BL314	315	316	317	318	319	L320
R320	321	322	323	324	325	326	327	328	329	330	331	332	333a	333b
333	334	335	TL336	BL336	337	338	339	340	341	342	343	344	345	346
347	TL348	BL348	349	350	351	352	353	354	355	356	357	358	359	L360
R360	361	L362	TR362	BR362	363	364a	364b	365	366	367	368	369	370	371
L372	TR372	CR372	BR372	373	374	375	376	377	378	379	380	381	382	383
T384	BL384	BR384	385	386	387	388	389	390	391	392	393	394	395	396
396a	396b	397	398	399	L400	TR400	BR400	401	402	403	404	405	406	407
408	409	410	411	412	413	414	415	416-7	418	419	L420	TR420	BR420	421
L422	TR422	BR422	423	L424	TR424	BR424	425	426	427	L428	TR428	BR428	428a	428b
429	430	431	432	433	435	436	437	438	439	L440	TR440	BR440	441	L442
TR442	BR442	443	TL444	BL444	BR444	445		447	T448	BL448	BR448	449	450	451
L452	R452	453	456	457	462	C3	C4							

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
76	77	78	79	80	81	82	83	84	85	86	87	88	89	90
91	92	93	94	95	96	97	98	99	100	101	102	103	104	105
106	107	108	109	110	111	112	113	114	115	116	117	118	119	120
121	122	123	124	125	126	127	128	129	130	131				

132	133	134	135	136	137	138	139	140	141	142	143	144	145	146
147	148	149	150	151	152	153	154	155	156	157	158	159	160	161
162	163	164	165	166	167	168	169	170	171	172	173	174	175	176
177	178	179	180	181	182	183	184	185	186	187	188	189	190	191
192	193	194	195	196	197	198	199	200	201	202	203	204	205	206
207	208	209	210	211	212	213	214	215	216	217	218	219		

Card expires November 1

CIRCLE THESE KEY NUMBERS FOR FURTHER DATA ON.....

CIRCLE THESE KEY NUMBERS FOR INFORMATION ABOUT.....

CIRCLE THESE KEY NUMBERS FOR YOUR COPIES OF.....

USE THIS SPACE TO INDICATE REQUIRED.....

85—Capacitor with Right-Angle Leads
86—Embedded Nuts
87—Relays for Operational Shock
88—Fabric-Backed Sponge Rubber
89—Resin for Electronic Embedment
90—Multi-Channel Sampling Switch
91—Portable Vibration Motor
92—Extruded Acrylic Sheet
93—Spindle Shaft Coupling
94—Miniature Connector
95—Minimizes Hydraulic Leaks
96—Flange-Mounted Radial Bearing
97—Glass Fiber Roving For Preforms
98—Miniature AC Motor-Generator Set
99—Tape Gun for Electrical Harness
100—Guaranteed Potentiometer
101—400-Cycle Transformer Weighs 1½ oz.
102—Extra-High Potential Measurement
103—Fhp, Shaded Pole Motor
104—Easily Mounted Speed Reducer
105—Tube Shields Lessen Heat
106—Ball-Bearing Connecting Rod Ends
107—Seals for Switches and Shafts
108—Miniature Tubing of Alumina
109—Vinyl That Is Foamed In Place
110—Makes Sample Springs and Parts
111—Coolant Mist Uses Evaporation
112—Sealed, Cageless Bearing
113—Miniature Lubricating System
114—UHF Insulating Laminate
115—Multiple Spline Socket Screw
116—Seals Caster Raceways, Bearings
117—Lock Box for Coin Machines
118—Reusable Self-Locking Nuts
119—Flexible Stock for Nameplates
120—Printed Circuit Receptacles
121—Floating Gearmotor
122—Plastic Air Hose
123—Loadmeter
124—Powdered Metal Spherical Washers
125—Electrical Instruments
126—Cast Iron Alloy for Abrasion
127—Low Amperage Motor Protector
128—Sub-Miniature Resistors
129—Sub-miniature Toggle Switches
130—Small-Diameter Metal Bellows
131—Linear Motion Controller

NEW BULLETINS . . . listed below are described on pages 305 to 320. Circle key number for your copy.

132—Impact Sockets, Adapters
133—Braided Packings
134—Chain Drives
135—Flexible Joints For Pipe Lines
136—Solenoid Valves
137—Copper-Clad Printed Circuits
138—Wear-Resistant Steel Alloy
139—Resistors
140—Lead-Bearing Steel
141—Hardenability of Steels
142—Investment Castings
143—Weldless Chain
144—Electrical Instruments
145—Metal Powders
146—Resistance Strips and Discs
147—Condensers and Compressors
148—Geared Motors
149—Variable Speed Reducers
150—Precision Potentiometers
151—Transformers
152—Colloidal Dispersions
153—Electric Heating Equipment
154—Rotary Pumps
155—Safety and Relief Valves
156—Cycle-Controlling Counters
157—Temperature Control Valve
158—Hose Couplings and Fittings
159—Interval Timers
160—High-Temperature Steel Tubing
161—Pressure Lubrication Filters
162—Nickel Alloy Steels
163—In-Line Valves
164—Solders
165—Beryllium Copper Strip
166—Fhp Variable Speed Motor Drive
167—Epoxy Resins
168—Double-Hex Nut
169—Phenolic Resins
170—Belt Drives
171—Plug Valve Actuators

PRINT or TYPE your address on other side before mailing

C2			1	2	4	6	8	10	12	13	14	15	16	17
18-0	20-1	22-3	24-5	26-7	28-0	30-1	32	32a	32b	32c	32d	33	34	35
36	37	38	39	40-1	42	43	44	45	46	47	48	49	50	51
52-3	54	55	56	57	58	59	60	61	62	63	64	64a	64b	65
66	67	68	69	70	71	72-3	74	75	76	77	78	79	80-1	82
83	84-5	86	87	88	89	90	91	92	93	94	95	96	96a	96b
96c	96d	97	98	99	100-1	102	103	104-5	106	107	108-9	110	111	112-3
	116-7	118-9	120-1	122	124	126	128	208	210	212	214	231	233	235
237	229	231	233	234-5	236	236a	236b	237	239	243	245	247	248	249
250	251		253	254	255	TL256	BL256	257	258	259	260	261	262	263
264	265	266	267	268	268a	268b	268c	268d	269	L270	R270	271	TL272	BL272
273	L274	R274	TR275	BR275	276	277	278	279	280	281	TL282	BL282	283	284
285	L286	R286	287	288	289	TL290	BL290	291	L292	R292	293	294	295	296
297	298	299	300	300a	300b	301	TL302	BL302	303	L304	R304	305	306	307
L308	R308	309	310	311	312	313	TL314	BL314	315	316	317	318	319	L320
R320	321	322	323	324	325	326	327	328	329	330	331	332	332a	332b
333	334	335	TL336	BL336	337	338	339	340	341	342	343	344	345	346
347	TL348	BL348	349	350	351	352	353	354	355	356	357	358	359	L360
R360	361	L362	TR362	BR362	363	364a	364b	365	366	367	368	369	370	371
L372	TR372	CR372	BR372	373	374	375	376	377	378	379	380	381	382	383
T384	BL384	BR384	385	386	387	388	389	390	391	392	393	394	395	396
396a	396b	397	398	399	L400	TR400	BR400	401	402	403	404	405	406	407
408	409	410	411	412	413	414	415	416-7	418	419	L420	TR420	BR420	421
L422	TR422	BR422	423	L424	TR424	BR424	425	426	427	L428	TR428	BR428	428a	428b
429	430	431	432	433	435	436	437	438	439	L440	TR440	BR440	441	L442
TR442	BR442	443	TL444	BL444	BR444	445		447	T448	BL448	BR448	449	450	451
L452	R452	453	456	457	463	C3	C4							

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
76	77	78	79	80	81	82	83	84	85	86	87	88	89	90
91	92	93	94	95	96	97	98	99	100	101	102	103	104	105
106	107	108	109	110	111	112	113	114	115	116	117	118	119	120
121	122	123	124	125	126	127	128	129	130	131				

132	133	134	135	136	137	138	139	140	141	142	143	144	145	146
147	148	149	150	151	152	153	154	155	156	157	158	159	160	161
162	163	164	165	166	167	168	169	170	171	172	173	174	175	176
177	178	179	180	181	182	183	184	185	186	187	188	189	190	191
192	193	194	195	196	197	198	199	200	201	202	203	204	205	206
207	208	209	210	211	212	213	214	215	216	217	218	219		

Card expires November 1

...PRODUCTS ADVERTISED
...NEW PRODUCTS . . .
...NEW BULLETINS . . .
...SPECIFIC DATA . . .

172—Solid Tires and Wheels
173—Safety Valve
174—Titanium Alloy
175—Molybdenum Disulfide
176—Alloys for Anchoring Parts
177—Control Valves
178—Steel Valves
179—Capacitors
180—Flow Regulators
181—Motorized Reducers
182—Variable Speed Liquid Drives
183—Pneumatic Controller
184—Chemical Feeder
185—Needle Control Valves
186—Meters and Controls
187—Zirconium
188—Timing Motors
189—Grinding Wheels
190—Flame-Plating
191—Stainless Fastenings
192—Iron Powder Cores
193—Copper-Clad Printed Circuits
194—Miniature Repeat Cycle Timers
195—Metering Flow Tube
196—Tamper-Proof Sealer
197—Precision Components
198—Aluminum Alloy Designations
199—Wire Thread Inserts
200—Roller Chain and Sprockets
201—Flow Regulators
202—Check Valves
203—Solenoid Valves
204—Hydraulic Drive Units
205—Control Valves
206—A-c and D-c Generators
207—Centrifugal Pumps
208—Float Position Transmitters
209—Linear Accelerometers
210—Hydraulic Pump
211—Vibration and Shock Mountings
212—Miniature Capacitors
213—Multiple Stage Flow Meter
214—Fine Wire, Foil, Ribbon
215—Actuator Motor
216—Fasteners
217—Electrically Variable Inductor
218—Variable Speed Motor Pulleys
219—Castings

USE THIS SERVICE . . .

. . . to get your copies of new Catalogs and Bulletins

. . . to get your copies of new Catalogs and Bulletins

. . . for more information about products advertised in this issue

PRINT or TYPE your address before mailing

PLEASE TYPE OR PRINT

Name _____

Position _____

Company _____

Address _____

City & State _____ 9-54

FIRST CLASS
PERMIT No. 64
(Sec. 34.9 P.L.&R.)
NEW YORK, N. Y.

BUSINESS REPLY CARD
NO POSTAGE STAMP NECESSARY IF MAILED IN THE UNITED STATES

—4¢ POSTAGE WILL BE PAID BY—

PRODUCT ENGINEERING
READER SERVICE DEPARTMENT
330 WEST 42nd ST.
NEW YORK 36, N. Y.

Requests for information made through *Product Engineering* Readers' Service will be forwarded to the manufacturer as quickly as we can process them. If you write directly to the manufacturer, please identify advertisement by issue and page number to facilitate reply.

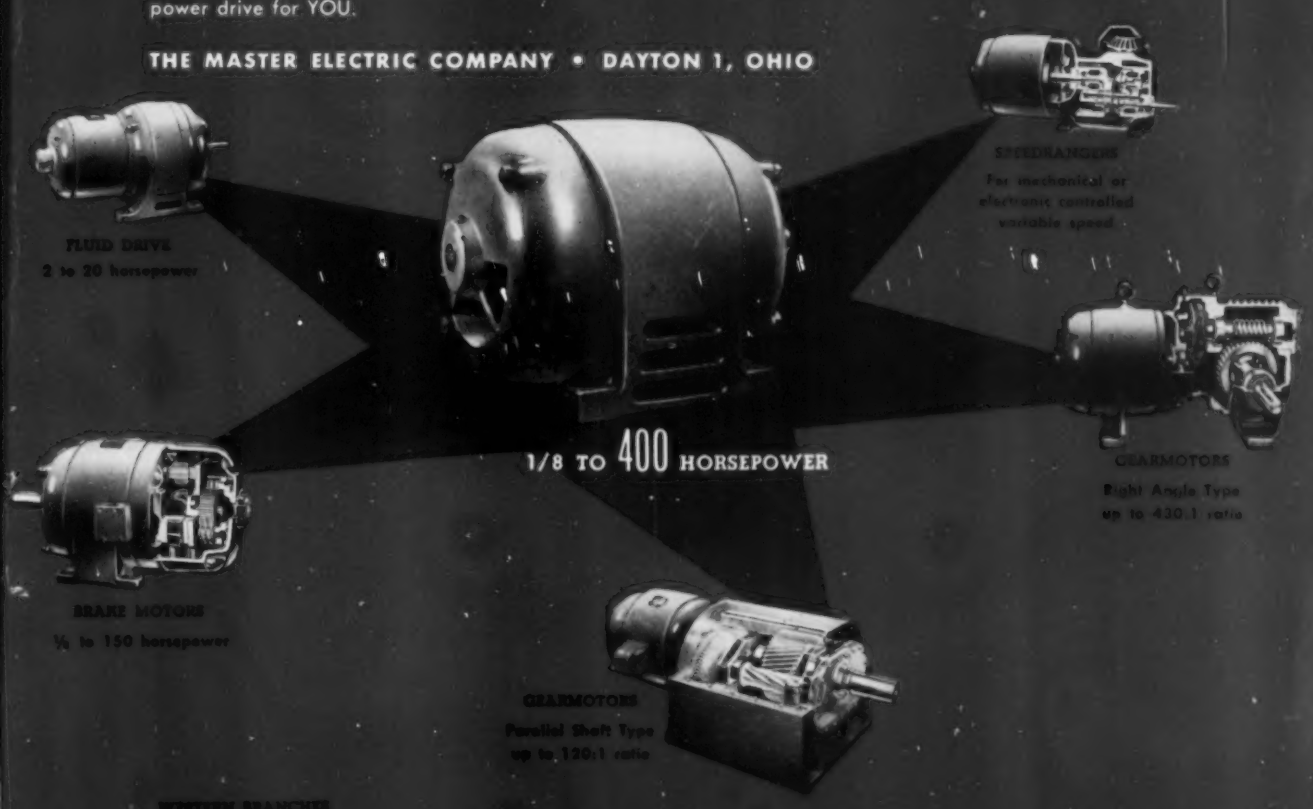
Whenever you select a power unit, don't put a straight-jacket on your ideas . . . consider ALL of the possibilities of modern power drives.

For example consider the many useful combinations that can be secured with the basic Master power units shown below. They're designed so they can be easily combined together to give you the RIGHT horsepower, the RIGHT shaft speed, the RIGHT features in one compact unit that you can use RIGHT where you want it. Nowhere else will you find power units that are so flexible, so easily adaptable, and in such a wide range of types and ratings.

Master power drives are available in thousands and thousands of ratings (⅛ to 400 HP) . . . in open, enclosed, splash proof, fan cooled, explosion proof . . . horizontal or vertical . . . for all phases, voltages and frequencies . . . in single speed, multi-speed and variable speed types . . . with or without flanges or other special features . . . with 5 types of gear reduction up to 430 to 1 ratio . . . with electric brakes . . . with fluid-drive . . . with mechanical or electronic variable speed units . . . and for every type of mounting . . . Master has them all and so can be completely impartial in helping you select the one best power drive for YOU.

THE MASTER ELECTRIC COMPANY • DAYTON 1, OHIO

give your brains a chance



WESTERN BRANCHES

DENVER · SALT LAKE CITY · PORTLAND · SPOKANE · SEATTLE · LOS ANGELES · SAN FRANCISCO

THE C. ALLEN FULMER COMPANY uses Timken bearings on the input and output shafts of the world's largest vertical honer to carry heavy loads and keep gears in positive alignment.

World's biggest vertical honer takes heavy thrust on TIMKEN® bearings

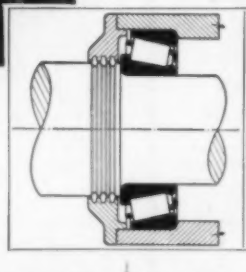
THIS 30" x 144" Fulmer Honing Machine is the biggest vertical honing machine ever built, designed to hone 30′ aircraft launching catapult tubes in only three passes.

The output shaft bearings in this machine have to take the tremendous thrust loads imposed by the weight of the honed parts and the up and down thrusts of the hone itself. Having relied on the quality of Timken® bearings in honing machines for many years, Fulmer engineers specified them for the input and output shafts of this unique machine. Due to their tapered construction, Timken bearings take radial and thrust loads in any combination.

Line contact between the rollers and races gives Timken bearings extra load-carrying capacity. The precision manufacture and incredibly smooth surface finish of Timken bearings virtually eliminate friction. And because shafts and housings are held concentric, seals are more effective. Lubricant is retained, dirt and moisture are kept out.

Timken bearings are made of fine alloy steel. To be sure of getting the quality we insist on, we make our own steel. And we're the only U. S. bearing manufacturer who does! Under normal use, Timken bearings last the life of the machine. Specify them in the machines you buy or build. Look for the trade-mark "Timken" on every bearing. The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ont. Cable address: "TIMROSCO".

This symbol on a product means its bearings are the best.



LUBRICANT STAYS IN —DIRT KEPT OUT

Because Timken bearings hold shafts concentric with housings, closures are made more effective. Lubricant is retained, dirt and moisture kept out.

The Timken Roller Bearing Company is the acknowledged leader in: 1. advanced design; 2. precision manufacture; 3. rigid quality control; 4. special analysis Timken steels.

TIMKEN

TRADE-MARK REG. U. S. PAT. OFF.

TAPERED ROLLER BEARINGS

NOT JUST A BALL ○ NOT JUST A ROLLER ▭ THE TIMKEN TAPERED ROLLER ▭ BEARING TAKES RADIAL ▯ AND THRUST ▯ LOADS OR ANY COMBINATION ✳